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WATER QUALITY AND WASTEWATER LOADINGS, UPPER POTOMAC ESTUARY DURING 1969

Norbert A. Jaworski

Federal Water Pollution Control Administration
Annapolis, Maryland

November 1969

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MIDDLE ATLANTIC REGION

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Chesapeake Technical Support Laboratory
Middle Atlantic Region
Federal Water Pollution Control Administration
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Technical Report No. 27

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AND
WASTEWATER LOADINGS
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Norbert A. Jaworski

November 1969

Supporting Staff:

Johan A. Aalto, Chief, CTSL
Donald W. Lear, Jr., Chief, Ecology Section
James W. Marks, Chief, Laboratory Section

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CHAPTER I

INTRODUCTION

The third session of the Potomac River-Washington Metropolitan Area Enforcement Conference, convened in April and May of 1969, resulted in agreement by the conferees on a set of recommendations as a basis for future corrective action. To measure progress in the implementation of the recommendations, meetings will be held every six months.

This report has been developed to provide the conferees and others interested the current status of the water quality, wastewater loading and control needs. The scope of this report is limited to current conditions (1969) in the Potomac Estuary.

This is one of five technical reports prepared by the Chesapeake Technical Support Laboratory (CTSL) of the Middle Atlantic Region, Federal Water Pollution Control Administration (FWPCA) of the Department of the Interior, to define the water quality in the entire Potomac River basin. The other reports include inventories of municipal and industrial waste discharges, water quality and nutrient studies, and effects of mine drainage in the upper basin.

CHAPTER II

SUMMARY AND CONCLUSIONS

Based upon 1969 estuary data collected by personnel of the U. S. Geological Survey; Dalecarlia Filtration Plant, U. S. Army Corps of Engineers; Department of Sanitary Engineering, District of Columbia; Chesapeake Technical Support Laboratory (CTSL) and by the wastewater treatment facilities in the Washington metropolitan area, an analysis of current water quality conditions and wastewater loadings was made and is summarized below:

1. The fresh water inflow from the upper Potomac basin for the first eight months of 1969 was non-typical in that below average flows occurred during the first six months and above normal flows during the months of July and August.

2. For the first eight months of 1969, about 55 percent or 129,000 lbs/day of the biochemical oxygen demand (BOD) entering the Potomac Estuary from all major sources was from wastewater discharges in the Washington area.

3. Also for the first eight months, wastewater discharges in the Washington area contributed about 86 percent of the total phosphorus (27,000 lbs/day as P) and 66 percent of the total nitrogen (51,500 lbs/day as N).

4. Of the more than 851,000 lbs/day of total carbon entering the upper estuary from all sources during the first eight months in 1969, about 689,000 lbs/day were from the upper basin, mainly in the form of inorganic carbon (carbonic acid and bicarbonates).

5. Dissolved oxygen (DO) concentrations of less than 2.0 mg/l were regularly observed near the Woodrow Wilson Bridge from May through September 1969.

6. Even when the fresh water inflow increased to 9,000 cfs, as occurred in August, DO levels of 2.0 mg/l were measured in the upper estuary.

7. A fish kill occurred in the upper estuary near Woodrow Wilson Bridge between May 5 and 8, 1969. Dissolved oxygen concentrations were less than 1.0 mg/l on May 8 in the area of the kill.

8. As a result of increased chlorination of the wastewater treatment facility effluents, coliform densities were significantly lower in the area of the Woodrow Wilson Bridge than in 1968. For example, on September 29, 1969, fecal coliform densities exceeded 1,000 MPN/100ml at only one of 22 stations sampled.

9. High coliform densities were still prevalent at times in the area of Roosevelt Island where Rock Creek enters the estuary, probably the result of storm and combined sewer overflows.

10. High algal populations, as measured by chlorophyll "a", and high total organic carbon occurred in early March near Possum Point.

11. During the summer months, massive algal blooms occurred in the upper and middle estuary as far downstream as the U.S. Route 301 Bridge.

12. Depressed DO concentrations (below 2.0 mg/l) at the lower depths occurred during the summer months in the reach of the estuary from U.S. Route 301 Bridge to the Chesapeake Bay.

13. During August 1969, six samples taken from the estuary between Chain Bridge and U.S. Route 301 Bridge contained no detectable pesticides.

14. To facilitate the determination of wastewater discharge loadings, the estuary was zoned into fifteen mile reaches. Maximum waste discharge loadings for BOD (organic carbon), nitrogen, and phosphorus have been determined for Zone I in the Washington area. These loadings were adopted by the conferees at the May 8, 1969, session of the Potomac River-Washington Metropolitan Enforcement Conference.

15. Preliminary estimates of loadings have been established for Zone II downstream from the Washington area.

16. Field studies are currently being conducted by CTSL to further define nutrient transport and eutrophication characteristics in the upper and middle estuaries.

17. CTSL and the Southeast Regional Laboratory, FWPCA, are continuing studies to refine the nutrient requirements (carbon, nitrogen, and phosphorus) for algal growth especially in the area of salt water intrusion.

18. The effects on water quality in the lower estuary and the Chesapeake Bay of the highly eutrophic conditions in the upper and middle estuaries are not fully known.

19. The role of rooted aquatic plants (submerged and emergent) in nutrient storage and release has not been fully determined. This role is especially important where wastewater discharges are made into shallow embayments.

CHAPTER III

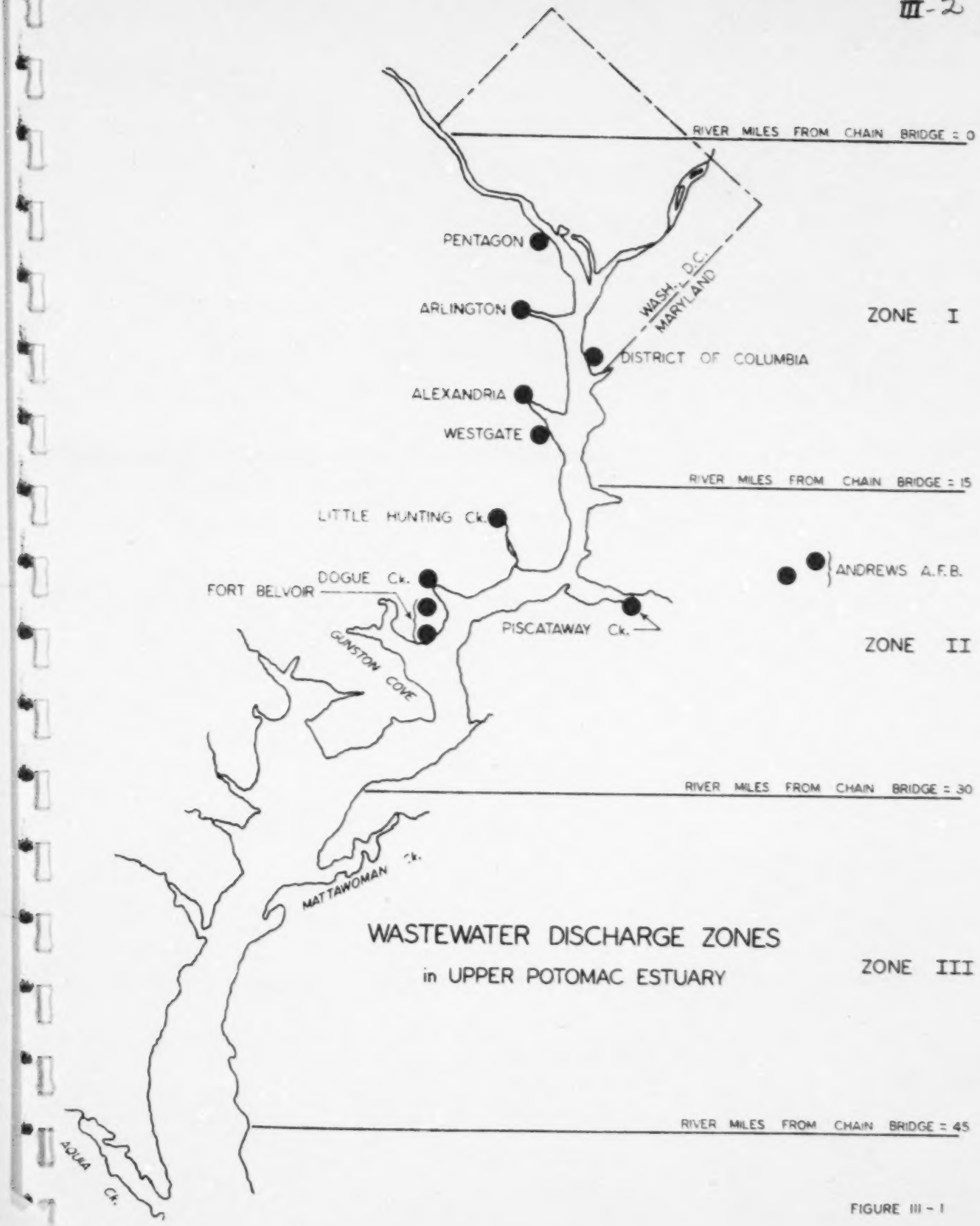
DESCRIPTION OF THE POTOMAC ESTUARY

The Potomac River Basin is the second largest watershed in the Middle Atlantic States. Its tidal portion begins at Little Falls in the Washington metropolitan area and extends 106 miles southeastward to the Chesapeake Bay.

The estuary is several hundred feet in width at its head near Washington and broadens to nearly six miles at its mouth. A shipping channel with a minimum depth of 24 feet is maintained upstream to Washington. Except for the channel and a small reach just below Chain Bridge where depths up to 80 feet are found, the estuary is relatively shallow with an average depth of about 15 feet.

The upper portion of the estuary from Marshall Hall at River Mile 85.0 to Little Falls above Washington is fresh water. In the middle portion of the estuary from Marshall Hall to Indian Head at River Mile 77.5, there is a transition zone from fresh to slightly brackish water. The upper boundary of the salt wedge varies with fresh water inflow and tidal stage.

Effluents from twelve wastewater treatment plants, serving a population of about 2,500,000 people, are discharged into the upper estuary. The locations of the discharges from these wastewater facilities are shown in Figure III-1. Also shown are the wastewater discharge zones in the upper estuary.



WASTEWATER DISCHARGE ZONES
in UPPER POTOMAC ESTUARY

FIGURE III - 1

CHAPTER IV

FACTORS AFFECTING WATER QUALITY

A. GENERAL

During the first eight months of 1969, the fresh water inflow from the upper Potomac basin was non-typical. River discharges were below normal for the first six months and above normal in July and August (Figure IV-1). This non-typical flow pattern had an effect on the water quality by variations in the relative contributions of carbon, nitrogen, and phosphorus.

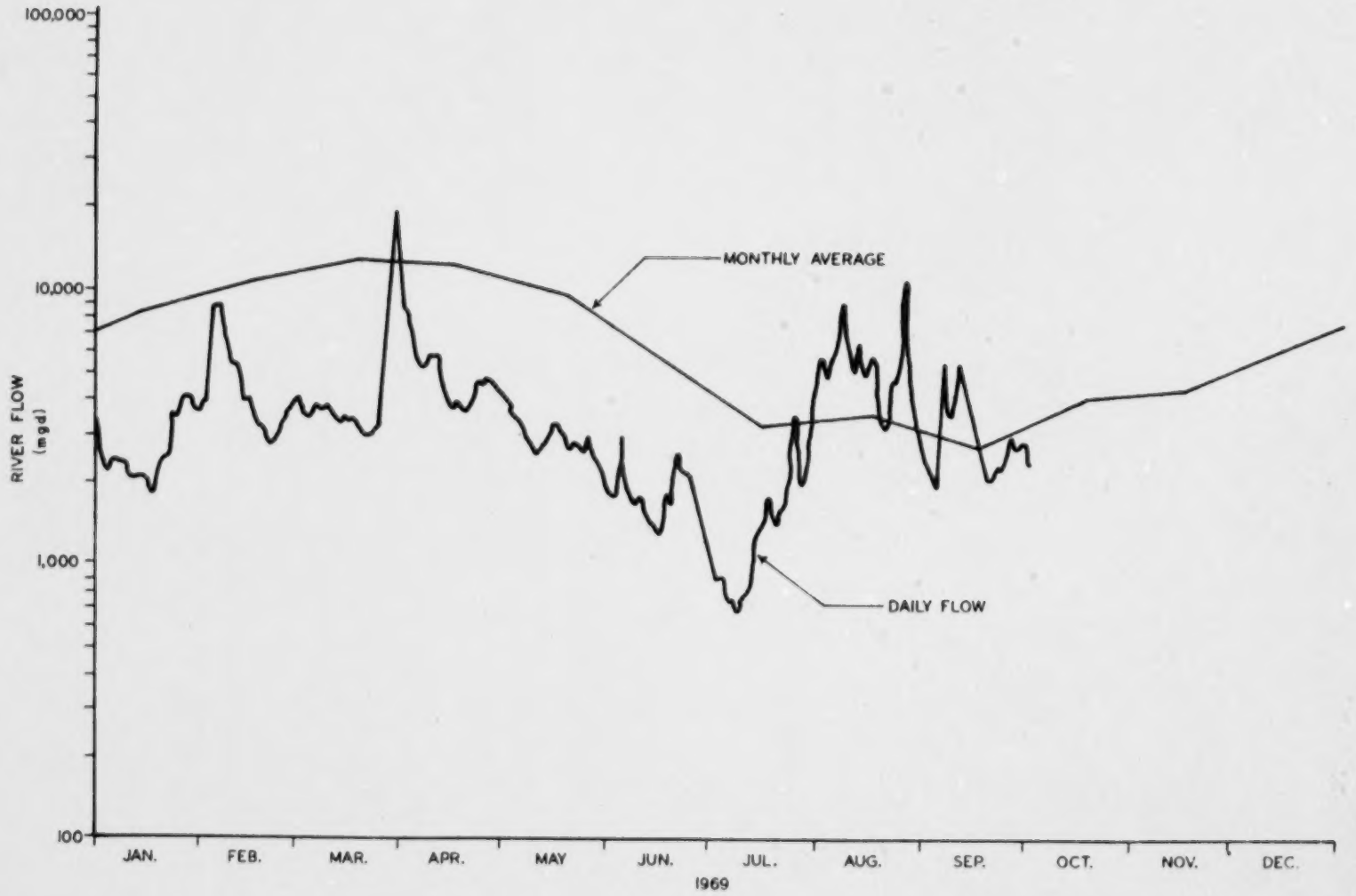

POTOMAC RIVER DISCHARGE
NEAR
WASHINGTON, D.C.
100,000
10,000
1,000
100
RIVER FLOW
(mgd)
MONTHLY AVERAGE
DAILY FLOW
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.
1969

FIGURE IV - 1

B. WASTEWATER DISCHARGES

Tables IV-1 and IV-2 present the biochemical oxygen demand (BOD), total organic carbon (TOC), suspended solids, nitrogen and phosphorus loadings from the 13 major wastewater discharges in the upper Potomac Estuary for the August 1969 intensive survey. The loadings measured were similar to those determined during the August 1968 intensive survey [1].

Of the 129,390 lbs/day of BOD discharged to the upper estuary, about 75 percent was from the District of Columbia waste treatment facility. While this is the major contributor, it should be noted that 44 percent of the population served by this treatment plant is in Maryland, 6 percent in Virginia, and the remaining 49 percent in the District of Columbia.

About 70 percent of the 5-day BOD is currently being removed by the treatment plants. In addition, the wastewater treatment facilities are currently removing about 23 percent of the total phosphorus and 20 percent of the total nitrogen.

TABLE IV-1
BOD, TOC, AND S.SOLIDS
WASTEWATER LOADINGS
Potomac Estuary Intensive Survey
August 11-18, 1969

Facility	Pop. Served	Flow (mgd)	BOD		TOC		S. Solids	
			Untreated (lbs/day)	Treated (lbs/day)	Untreated (lbs/day)	Treated (lbs/day)	Untreated (lbs/day)	Treated (lbs/day)
Pentagon	42,400	1.06	2,100	360	1,000	300	2,100	310
Arlington	246,700	19.30	32,200	5,400	12,400	3,400	35,400	6,600
Sewer overflow D. C. system	—	2.50	2,800	2,800	1,800	1,800	3,300	3,300
District of Columbia	1,750,000	273.00	305,000	94,000	204,700	83,300	370,000	119,000
Alexandria	190,000	23.60	50,000	11,300	15,200	4,400	51,400	11,500
Fairfax Westgate	124,400	11.83	24,900	12,200	16,300	6,200	20,000	8,200
Piscataway	50,000	7.26	6,850	360	3,000	670	7,700	670
Andrews AFB No.1	11,000*	0.73	1,400	155	320	130	380	60
Andrews AFB No.2	11,000*	0.08	100	15	30	10	35	10
Fairfax Hunting Creek	24,900	3.39	5,000	1,500	2,500	800	4,200	1,100
Fairfax Dogue Creek	19,100	2.23	3,800	800	1,500	500	3,300	700
Ft. Belvoir No.1	3,550	0.59	1,100	120	430	75	110	70
Ft. Belvoir No.2	18,400	2.34	3,500	380	2,200	310	3,800	325
Total	2,480,450	347.91	438,750	129,390	261,380	101,895	501,725	151,845

* total for both plants

TABLE IV-2
NITROGEN AND PHOSPHORUS
WASTEWATER LOADINGS
Potomac Estuary Intensive Survey
August 11-15, 1969

Facility	Flow (mgd)	T. Phos. as P		TKN		NH_3 as N	$NO_2 + NO_3$ as N	T. Nitrogen
		Untreated (lbs/day)	Treated (lbs/day)	Untreated (lbs/day)	Treated (lbs/day)	Treated (lbs/day)	Treated (lbs/day)	Treated (lbs/day)
Pentagon	1.06	60	50	440	220	140	80	300
Arlington	23.60	1,510	990	4,800	3,030	2,220	920	3,950
Sewer overflow D. C. system	2.50	200	200	410	410	270	0	410
District of Columbia	273.00	21,300	16,600	46,000	37,000	29,000	1,450	38,450
Alexandria	19.42	2,000	1,540	4,580	3,370	2,320	50	3,420
Fairfax Westgate	11.83	1,120	960	3,140	2,540	1,480	50	2,690
Piscataway	7.26	365	160	1,650	240	200	390	630
Andrews AFB No.1	0.73	50	45	70	50	40	30	80
Andrews AFB No.2	0.08	6	4	12	3	2	3	6
Fairfax Hunting Creek	3.39	275	270	720	550	430	25	575
Fairfax Dogue Creek	2.23	200	180	465	280	230	40	320
Ft. Belvoir No.1	0.59	25	15	145	30	20	55	85
Ft. Belvoir No.2	2.34	130	105	960	480	310	170	650
Total	347.91	27,241	21,119	63,392	48,200	36,642	3,263	51,463

C. FRESHWATER INFLOW

As part of a nutrient transport study in the Potomac Estuary, weekly water quality analyses of the Potomac River at Great Falls are being made by the U.S. Army Corps of Engineers' Dalecarlia Water Treatment Plant and CTSL personnel. During high flow periods daily analyses are conducted.

Table IV-3 shows the average monthly BOD, carbon, nitrogen, and phosphorus loadings from the upper Potomac basin as measured at Great Falls for the first eight months of 1969. It should be noted that during August the flows were about twice the normal average for this month. As a result of these high flows, the contributions of BOD, carbon, nitrogen, and phosphorus entering the estuary during the late summer months were much higher than normal. For example, from August 11 to 22, 1968, when the fresh water inflow was about 2,700 cfs, the BOD contribution from the upper basin was about 52,000 lbs/day as compared to 157,000 lbs/day during August of 1969.

TABLE IV-3

BOD, CARBON, NITROGEN, AND PHOSPHORUS

FRESH WATER INFLOW CONTRIBUTIONS

Potomac River near Washington, D. C.

Month	Average Monthly Flow (cfs)	BOD (lbs/day)	Organic Carbon (lbs/day)	Inorganic Carbon (lbs/day)	Total Carbon (lbs/day)	Total Phosphorus as PO_4 (lbs/day)	NO_2 NO_3 as N (lbs/day)	TKN (lbs/day)	Total Nitrogen (lbs/day
Jan.	4,000	80,000	145,000	384,000	529,000	5,000	9,000	5,000	14,000
Feb.	6,700	112,000	240,000	500,000	740,000	7,000	11,000	14,000	25,000
March	8,400	127,000	310,000	808,000	1,118,000	12,000	17,000	9,000	26,000
April	7,100	138,000	260,000	531,000	791,000	13,000	7,000	16,000	23,000
May	3,900	100,000	140,000	383,000	523,000	8,500	3,000	7,000	10,000
June	2,300	67,000	85,000	216,000	301,000	7,900	540	6,300	6,840
July	2,800	81,000	177,000	275,000	452,000	13,600	18,700	27,000	45,700
Aug.	8,100	157,000	385,000	674,000	1,059,000	19,900	28,400	39,000	67,400
Average	5,400	107,000	218,000	471,000	689,000	10,800	11,800	15,400	27,200

* Based on alkalinity data converted to inorganic carbon

D. COMPARISON OF SOURCES

For the first eight months of 1969, a comparison was made of the wastewater and fresh water inflow contributions and is presented in Table IV-4. The relative percentages contributed by fresh water inflow and wastewater discharge are given below:

Parameter	Fresh Water Inflow (% of total)	Wastewater Discharge (% of total)
BOD	45	55
Organic Carbon	68	32
Inorganic Carbon	89	11
Total Carbon	80	20
Total Phosphorus	14	86
Total Nitrogen	34	66

From the above tabulation, it can readily be seen that the three parameters most controllable by wastewater treatment are BOD, total phosphorus, and total nitrogen. Any attempt to control total carbon appears to be impractical at present since the largest percentage comes into the estuary in the uncontrollable inorganic form.

TABLE IV--

BOD, CARBON, NITROGEN, AND PHOSPHORUS

SUMMARY OF CONTRIBUTIONS

Upper Potomac Estuary
January-August 1969

Parameter	Unit	Freshwater Inflow	Wastewater Discharge	Total
Flow	mgd	3,500	350	3,850
BOD	lbs/day	108,000	129,000	237,000
Inorganic Carbon	lbs/day as C	471,000	60,000	531,000
Organic Carbon	lbs/day as C	218,000	102,000	320,000
Total Carbon	lbs/day as C	689,000	162,000	851,000
Total Phosphorus	lbs/day as P	3,600	21,000	24,600
Nitrite and Nitrate	lbs/day as N	11,800	3,300	15,100
Total Kjeldahl Nitrogen	lbs/day as N	15,400	48,200	63,600
Total Nitrogen	lbs/day as N	27,200	51,500	78,700

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CHAPTER V

CURRENT WATER QUALITY

A. BACTERIOLOGICAL

During June 1969, chlorination of the final effluent from the District of Columbia wastewater treatment facility was instituted. In September 1969, continuous chlorination of the final effluent was initiated by the City of Alexandria Sanitation Authority. Thus all effluents from all major wastewater treatment facilitites are currently being chlorinated.

This increase in chlorination has reduced bacterial densities in the upper estuary near the Woodrow Wilson Bridge as shown in Figure V-1. When the data for August 1968 and June 1969 were compared, the fecal coliform densities were found to be considerably lower for the 1969 surveys. However, high fecal coliform densities (over 60,000 to 80,000 MPN/100ml) were detected above Memorial Bridge reflecting the effects of storm water and combined sewer overflows.

Sampling data for the month of September by the Department of Sanitary Engineering, District of Columbia, indicate that the fecal coliform densities can be effectively controlled by chlorination (See Table A-5). At only one station near the Blue Plains facility was the fecal density greater than 1,000 MPN/100ml.

Intensive bacteriological surveys were conducted during two periods, March 24 to April 4 and July 31 to August 5, 1969. (Data tables in the Appendix) Salmonella bacteria were isolated in areas from Cabin John

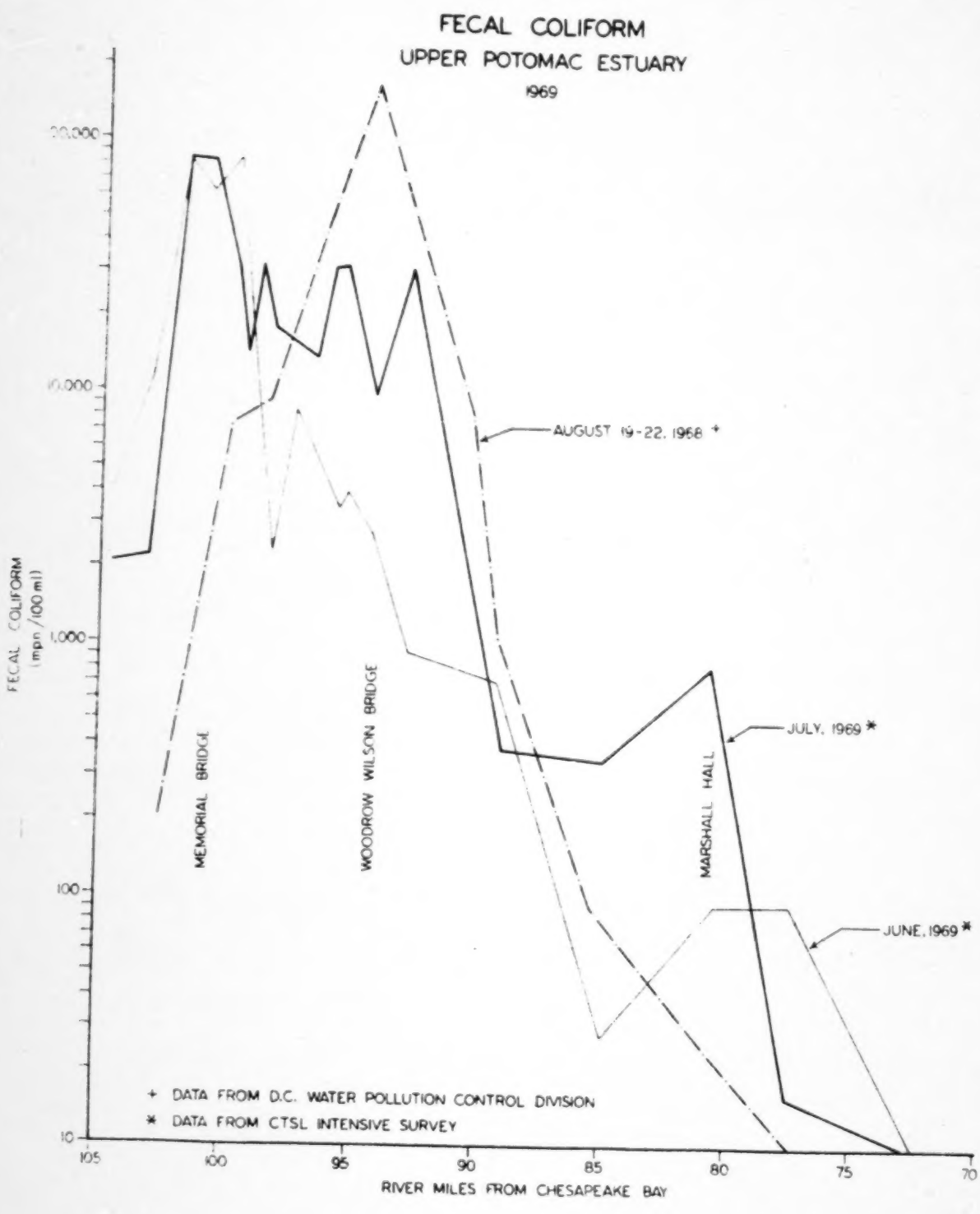
FECAL COLIFORM
UPPER POTOMAC ESTUARY
1969
FECAL COLIFORM (mpn/100 ml)
10,000
1,000
100
10
AUGUST 19-22, 1968 +
JULY, 1969 *
JUNE, 1969 *
MEMORIAL BRIDGE
WOODROW WILSON BRIDGE
MARSHALL HALL
+ DATA FROM D.C. WATER POLLUTION CONTROL DIVISION
* DATA FROM CTSL INTENSIVE SURVEY
105
100
95
90
85
80
75
70
RIVER MILES FROM CHESAPEAKE BAY

FIGURE V - 1

Creek to Dogue Creek during the spring survey which extended downstream to Piney Point in the lower estuary. During the summer survey, which was restricted to a reach from Great Falls to Woodrow Wilson Bridge, positive salmonella identification was made at three of the five stations sampled.

B. DISSOLVED OXYGEN, TOTAL ORGANIC CARBON, AND CARBON DIOXIDE IN THE UPPER ESTUARY

In early May 1969, a large fish kill occurred in the upper estuary near the Woodrow Wilson Bridge. Three sampling cruises on the estuary indicated dissolved oxygen (DO) concentrations, especially on May 8, 1969, when the DO was less than 1 mg/l in the area of the kill (Tables V-1, V-2, and V-3).

Figure V-2 shows DO profiles for the upper estuary for sample cruises in June, July, and August 1969. Dissolved oxygen concentrations of less than 2.0 mg/l were measured on August 17, 1969, when the fresh water inflow was as high as 8,890 cfs. Increase in fresh water inflow caused the minimum DO point to move further downstream as is evident by comparing the June 30 and August 14 profiles.

The increase in total organic carbon (TOC) from the wastewater discharges, shown in Figure V-3, is fairly closely related to low DO. As in the case of DO, the effect of increased fresh water inflow is the movement of the point of maximum TOC concentration downstream.

As a result of laboratory studies by FWPCA's Southeast Regional Office, reported by Williams [1] and a paper presented by Kneutzel [2], inorganic carbon including carbon dioxide (CO_2) measurements were initiated by CTSL during the summer of 1969. Preliminary data indicate a considerable increase in CO_2 near the wastewater discharge points followed by a decrease in areas of large algal growths. (Tables A-1 and A-2) However, significant levels of bicarbonates were always present in the areas of high algal densities.

TABLE V-1
POTOMAC ESTUARY FISH KILL CRUISE
May 8, 1969
CHESAPEAKE TECHNICAL SUPPORT LABORATORY

Estuary Location	Time Sample Taken	Water Depth Feet	Sample Depth Feet	Water Temp °C	Secchi Disk Inches	DO mg/l
14th Street Bridge	1310	17	Surface	21.5		6.88
			15	21.5		6.05
Haines Point - N 2		17	Surface	20.5	20	4.65
			15	20.5		4.37
Blue Plains - 23' Bell	1410	25	Surface	21.0	24	.70
			Surface	21.0		.76
			20	20.5		4.40
			20	20.5		1.10
Below Blue Plains - Buoy 8	1415	25	Surface	21.5	26	0.90
			20	21.0		0.89
Woodrow Wilson Bridge	1455	28	Surface	20.5	28	0.74
			20	20.5		0.50
Broad Creek - N 86	1500	30	Surface	20.0	24	0.99
			25	20.0		0.84
Fort Washington - Buoy 79	1515	25	Surface	20.5	13	1.67
			20	20.0		2.34
Mt. Vernon "71" - Maryland Shore	1525	20	Surface	19.5	18	2.82
			20	20.0		3.02
Mt. Vernon "71" - Channel		25	Surface	19.5		2.88
			20	19.5		2.90
Mt. Vernon "71" - Virginia Shore		20	Surface	20.0		2.94
			20	20.0		3.41

TABLE V-2
POTOMAC ESTUARY FISH KILL CRUISE
May 15, 1969
CHESAPEAKE TECHNICAL SUPPORT LABORATORY

Estuary Location	Time Sample Taken	Sample Depth Feet	Water Temp °C	Total P mg/l PO_4	$NO_2 + NO_3$ mgl NO_3-N	NH_3 mg/l	DO mg/l	TOC* mg/l
Off Haines Point - Anacostia	1500	10	22	.438	.297	.260	5.07	12.0
Haines Point - Potomac - Buoy 4	1505	10	18	.329	.390	.035	8.50	
14th Street Bridge	1525	10	19	.420	.342		8.53	10.7
Giesboro Point - Buoy 11 - mid-channel	1545	10	20	.454	.331	.143	8.03	15.8
Navy Pier - mid-channel	1605	10	22	.459	.363	.268	9.35	10.2
Power Plant outfall - PEPCO	1620	Surface	25	.755	.382	.188	8.99	10.4
Woodrow Wilson Bridge - mid-channel	1645	10	22	2.442	.233	1.128	6.08	5.3
Off Fort Foote - Red Buoy 2	1700	10	21.5	1.834	.294	.698	6.27	5.1
Broad Creek - near Buoy 86	1720	10	21.5	2.939	.241	1.025	4.75	7.5
Between Broad and Swan Creeks	1805	10	20	2.221	.191	.600	3.06	5.2
Swan Creek - mid-channel	1825	10	20	2.376	.180	1.575	2.10	4.6
Fort Washington - mid-channel	1845	10	20	2.044	.220	2.413	2.50	4.4
Piscataway - Buoy 77 - mid-channel	1900	10	20	2.177	.191	2.375	3.37	5.2
Mt. Vernon - Buoy 73 - mid-channel	1925	10	19.5	2.055	.247	3.150	2.84	4.0
Middle of Piscataway embayment - near Marina	1940	Surface	20	2.044	.141	1.093	3.83	3.6

* Analysis run by FWPCA-DC Pilot Plant.

TABLE V-3
POTOMAC ESTUARY FISH KILL CRUISE
May 16, 1969
CHESAPEAKE TECHNICAL SUPPORT LABORATORY

Estuary Location	Time Sample Taken	Sample Depth Feet	Water Temp °C	Secchi Disk Inches	DO mg/l
14th Street Bridge	1130	Surface	19	32	10.36
		15	21		8.49
First Bridge, Anacostia River	1215	Surface	19	15	4.23
		20	21		4.24
Haines Point - C 1	1230	Surface	19.5	25	9.79
		10	20		10.73
Bolling AFB - C 9	1240	Surface	19	23	9.69
		20	19		8.87
Blue Plains - 23' bell	1250	Surface	19	23	8.50
		20	19		7.25
Below Blue Plains - Nun 8	1255	Surface	19.8	18	5.59
		20	20		5.59
Woodrow Wilson Bridge	1305	Surface	19.5	24	6.91
		20	20		4.68
Broad Creek - N 86	1315	Surface	20	26	4.30
		25	20		2.67
Piscataway Creek	1328	Surface	20	25	3.65
		40	19.5		2.79
Dogue Creek - Flash 67	1343	Surface	20	26	3.45
		20	20		2.73
Hallowing Point - C 61	1355	Surface	20.2	22	6.38
		25	19.8		4.70
Indian Head - N 54	1410	Surface	20	22	6.38
		25	19.5		5.22

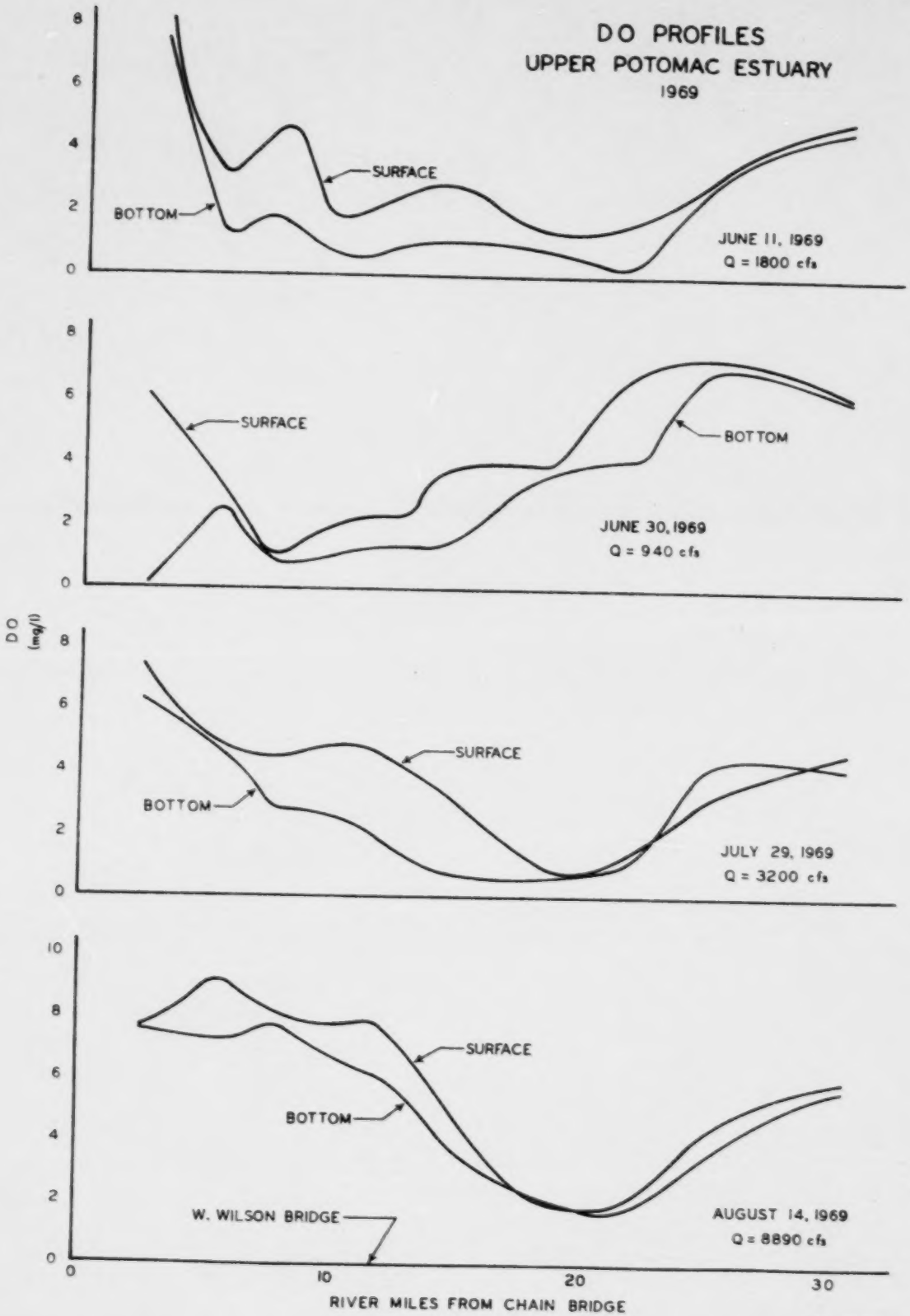
DO PROFILES
UPPER POTOMAC ESTUARY
1969
SURFACE
BOTTOM
JUNE 11, 1969
Q = 1800 cfs
SURFACE
BOTTOM
JUNE 30, 1969
Q = 940 cfs
DO (mg/l)
SURFACE
BOTTOM
JULY 29, 1969
Q = 3200 cfs
SURFACE
BOTTOM
W. WILSON BRIDGE
AUGUST 14, 1969
Q = 8890 cfs
0
2
4
6
8
10
0
10
20
30
RIVER MILES FROM CHAIN BRIDGE

FIGURE V-2

TOTAL ORGANIC CARBON PROFILES
UPPER POTOMAC ESTUARY
1969

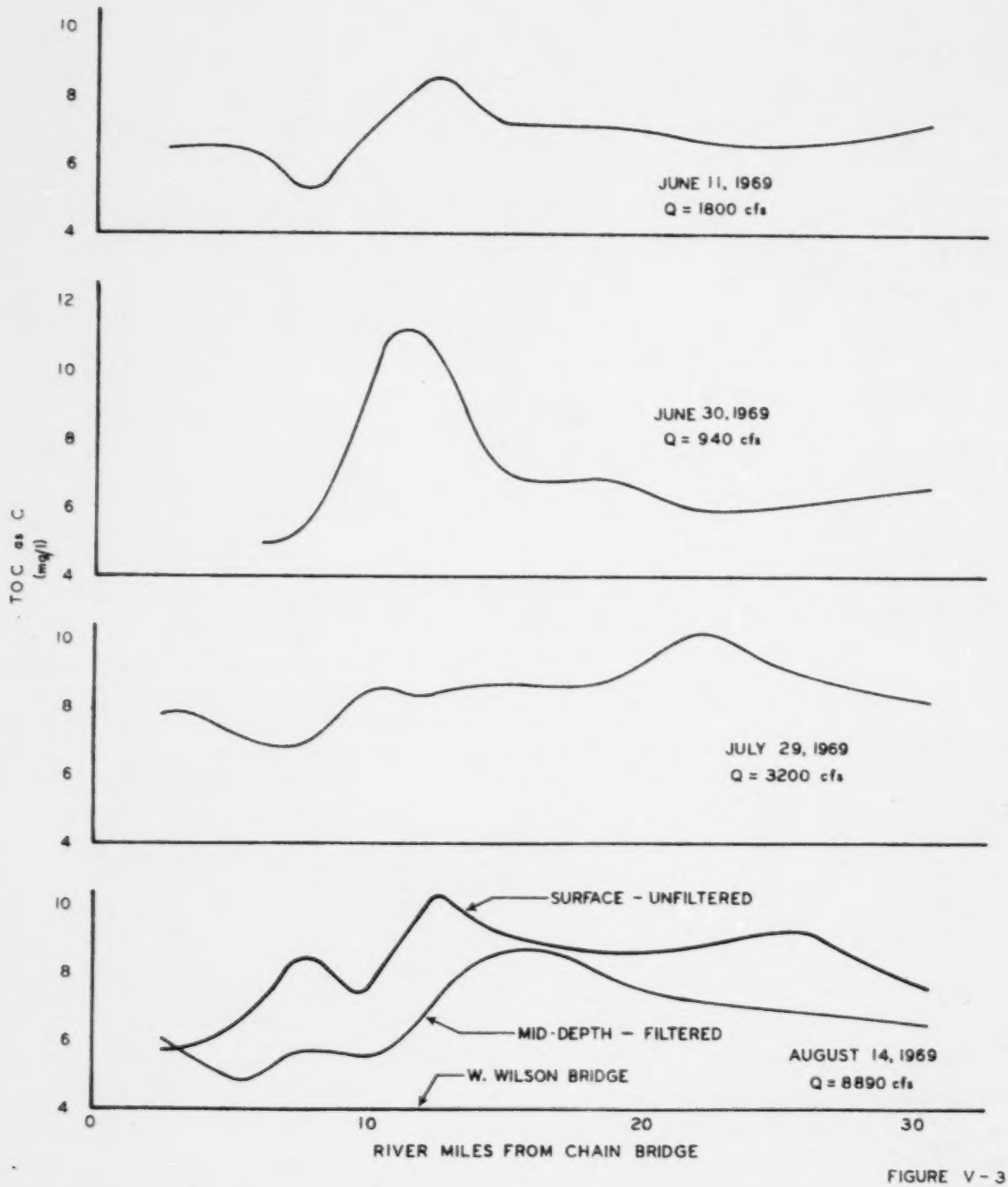

FIGURE V - 3

C. NUTRIENTS (PHOSPHORUS AND NITROGEN)

For the same dates as for the DO and TOC, data profiles for three nutrient parameters--phosphate (PO_4), ammonia (NH_3), and nitrite + nitrate (NO_2+NO_3)--are shown in Figures V-4, V-5, and V-6, respectively. The large increases in PO_4 and NH_3 were caused by the wastewater discharges in the Washington metropolitan area as presented in the previous chapter.

The increase in NO_2+NO_3 concentrations is a result of the oxidation of NH_3 to the more stable state. Figures V-4 and V-5 illustrate these occurrences. Previous studies have indicated that this oxidation process has a greater influence on DO than the oxidation of organic carbon [3].

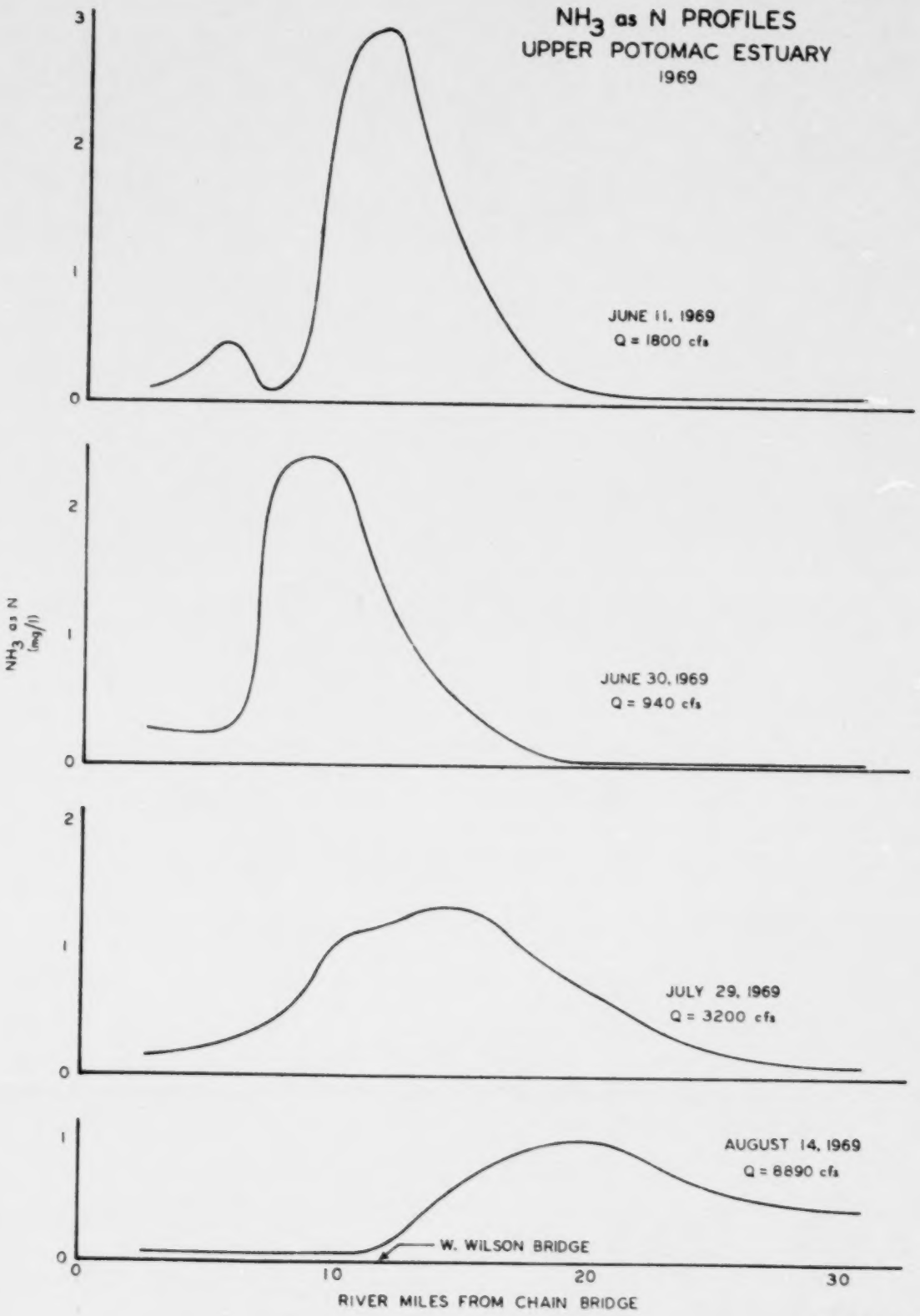
NH3 as N PROFILES
UPPER POTOMAC ESTUARY
1969
JUNE 11, 1969
Q = 1800 cfs
JUNE 30, 1969
Q = 940 cfs
JULY 29, 1969
Q = 3200 cfs
AUGUST 14, 1969
Q = 8890 cfs
W. WILSON BRIDGE
NH3 as N (mg/l)
RIVER MILES FROM CHAIN BRIDGE
0
10
20
30

FIGURE V-4

$NO_2 + NO_3$ as N PROFILES
UPPER POTOMAC ESTUARY
1969

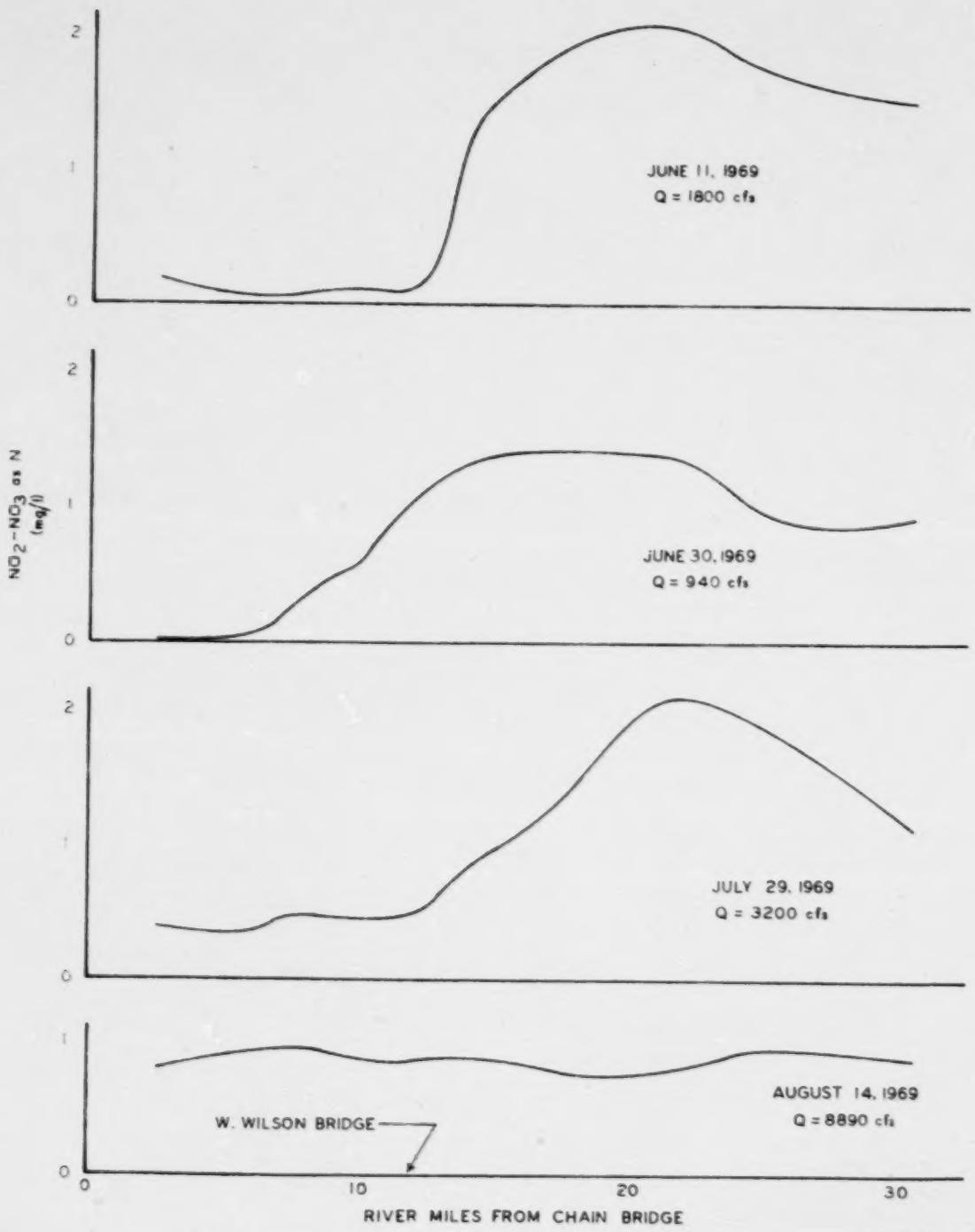

FIGURE V - 5

TOTAL PHOSPHORUS PROFILES
UPPER POTOMAC ESTUARY
1969

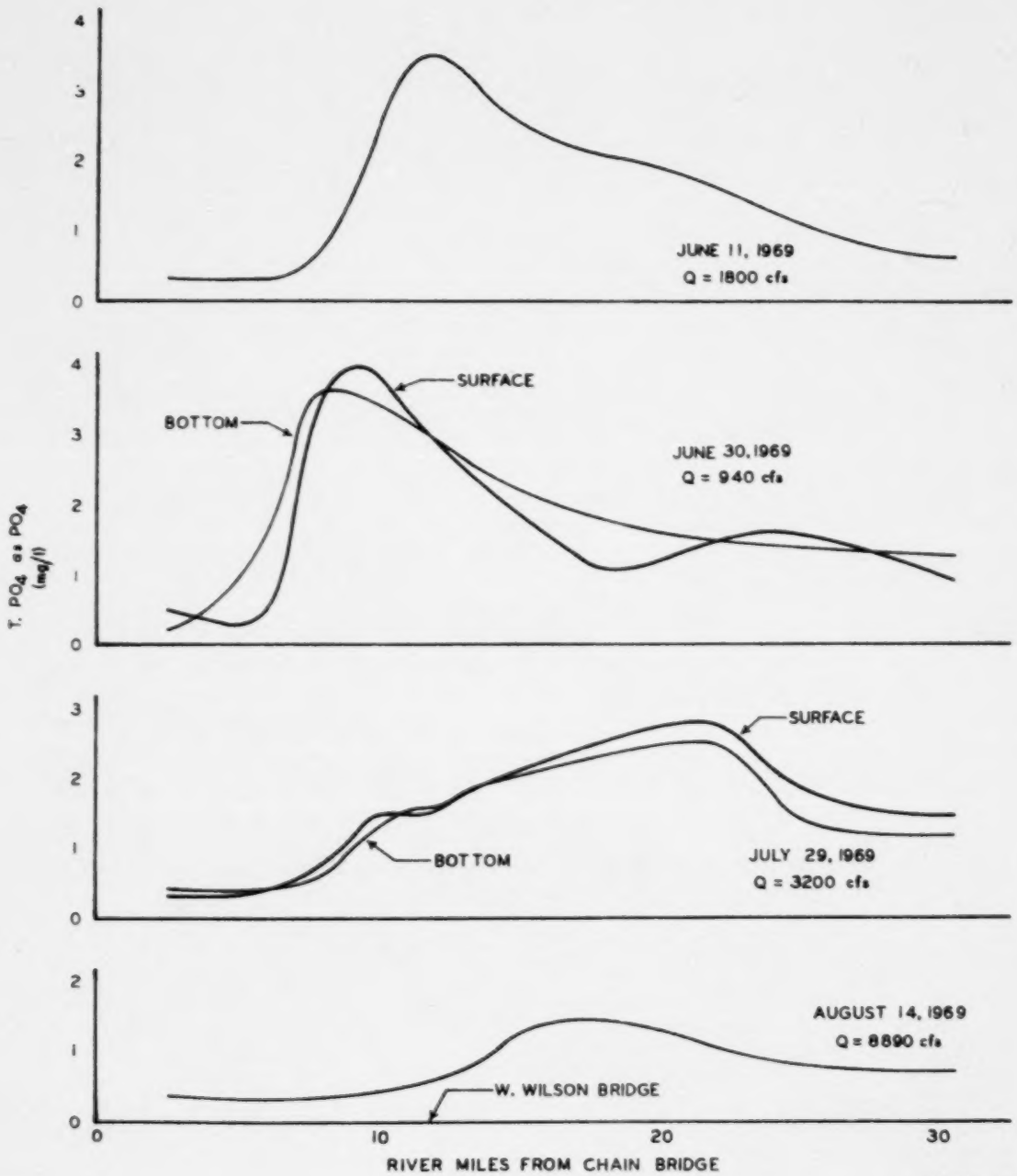

FIGURE V-6

D. CHLOROPHYLL

Chlorophyll "a" was used as a measure of algal standing crops. Phytoplankton levels on the four sampling dates previously mentioned and for three stations in the middle part of the estuary are shown in Figures V-7, V-8, V-9, and V-10.

The chlorophyll levels in Figure V-7 show significant increases in phytoplankton from June 11 to June 30, 1969. The high flows of late July and early August resulted in movement of bloom conditions further downstream in the estuary.

The temporal chlorophyll "a" plots (Figures V-8, V-9, and V-10) for the Potomac Estuary near Piscataway, Indian Head, and Possum Point, respectively, demonstrate the seasonal change in phytoplankton quantities. In March 1969, with water temperatures near 4° C., a large bloom of diatoms was verified in the estuary near Possum Point.

Near Piscataway, the chlorophyll levels increased during May and June (Figure V-8). However, the effect of the rather large fresh water inflows during mid and late July in moving the algal blooms further downstream can also be seen in Figures V-8 and V-9.

CHLOROPHYLL a PROFILES
UPPER POTOMAC ESTUARY
1969

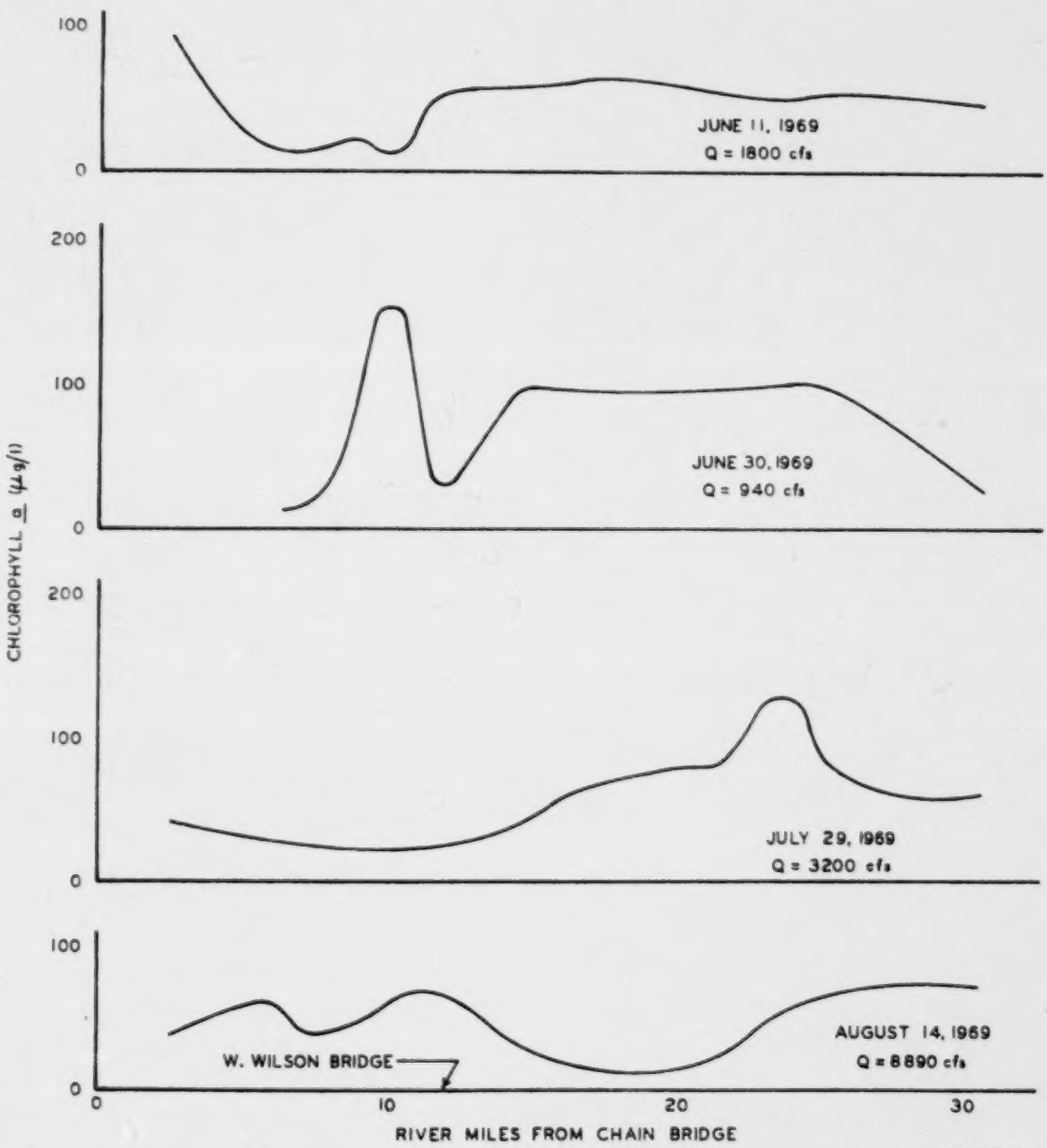

FIGURE V-7

CHLOROPHYLL a

POTOMAC ESTUARY at PISCATAWAY CREEK

RIVER MILES = 90.0

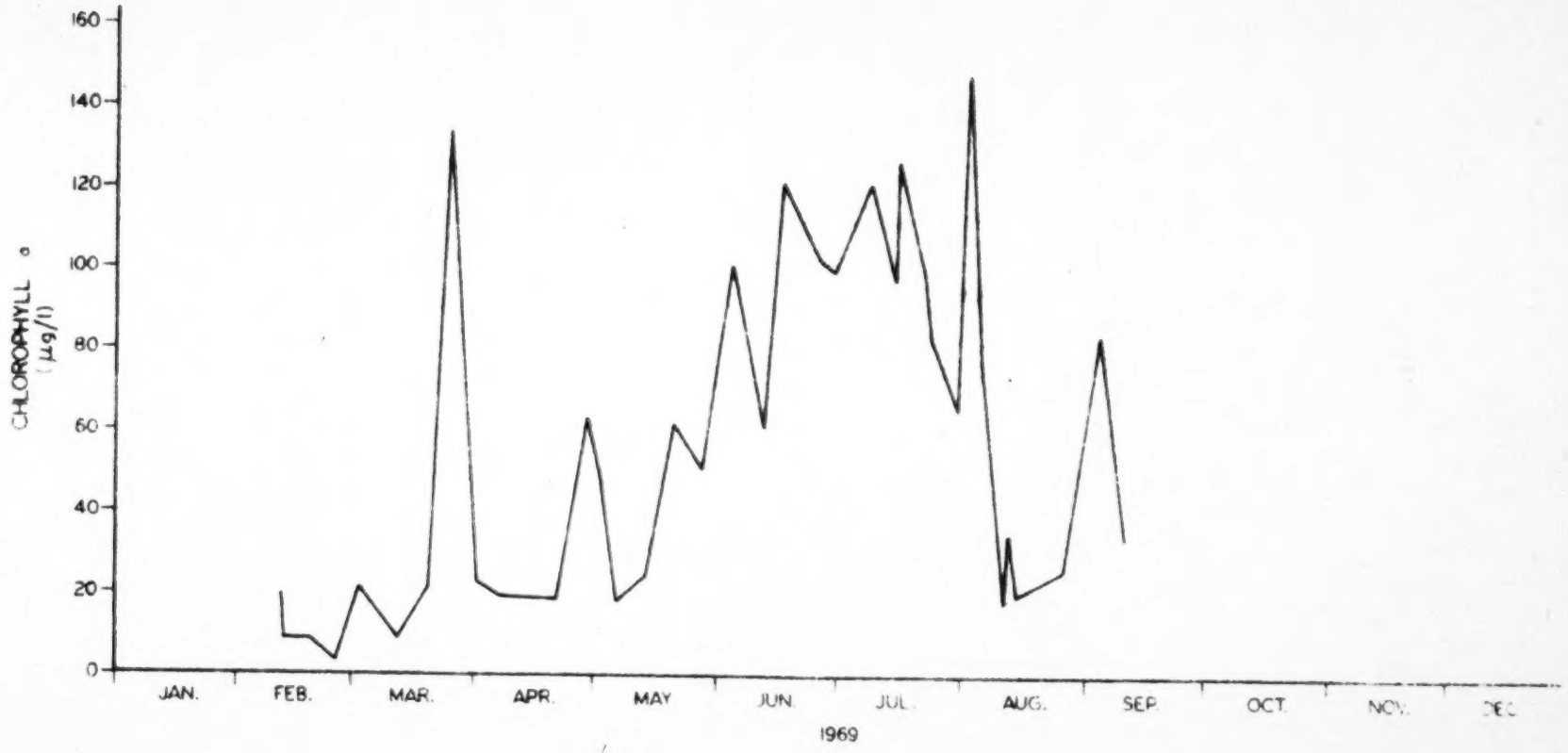

FIGURE V - 8

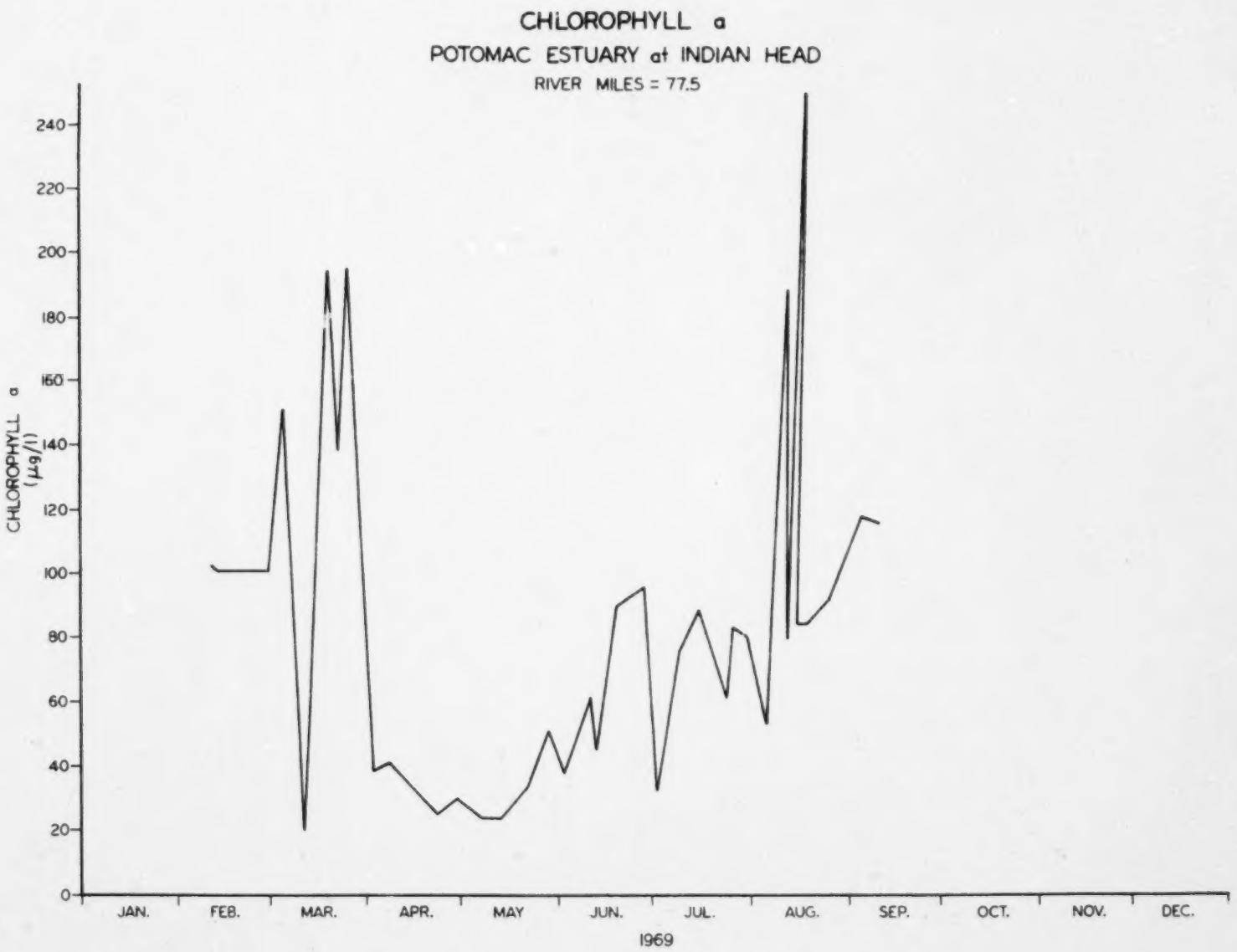
CHLOROPHYLL a
POTOMAC ESTUARY at INDIAN HEAD
RIVER MILES = 77.5
CHLOROPHYLL a (µg/l)
0
20
40
60
80
100
120
140
160
180
200
220
240
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.
1969

FIGURE V-9

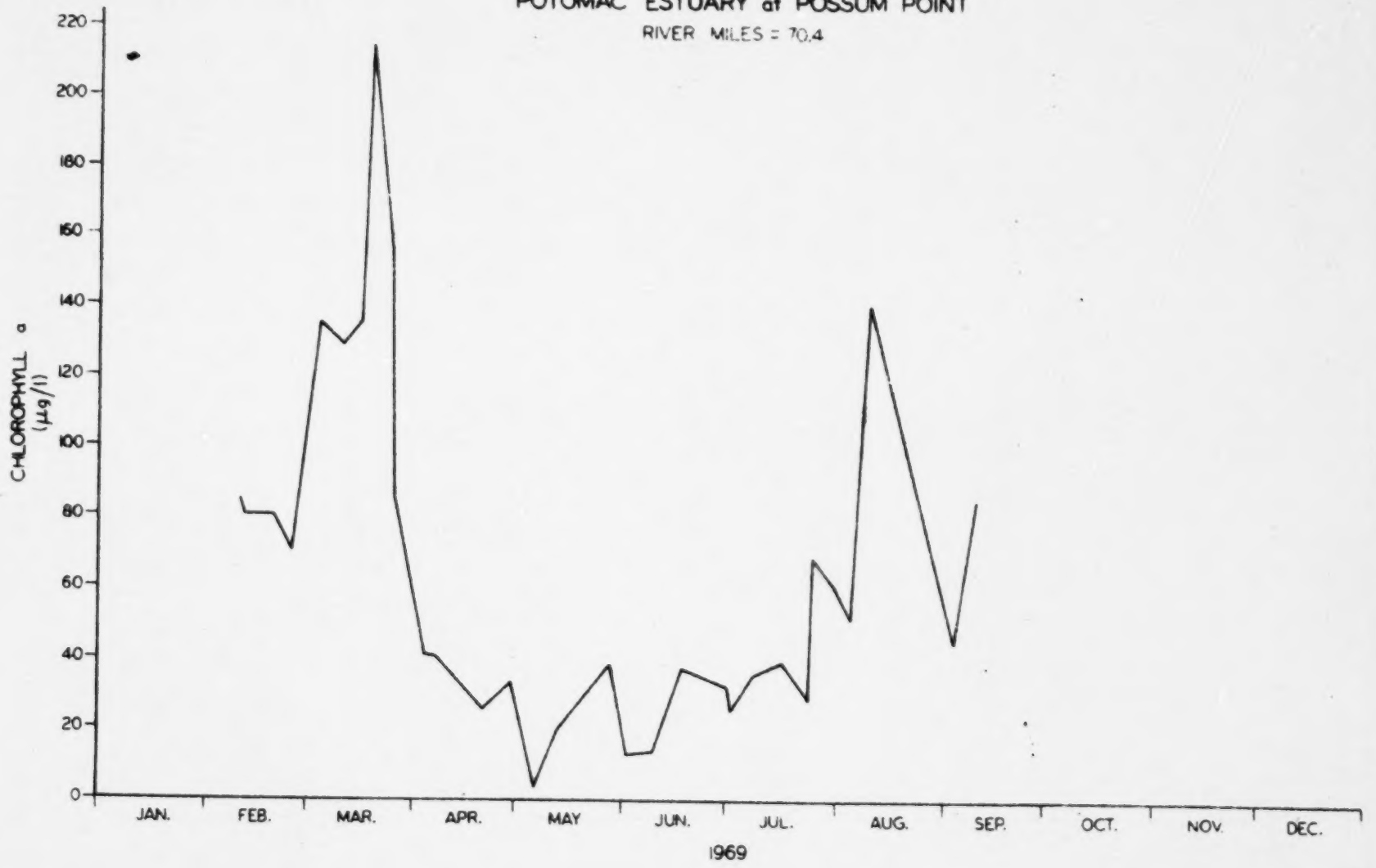
CHLOROPHYLL a
POTOMAC ESTUARY at POSSUM POINT
RIVER MILES = 70.4
CHLOROPHYLL a (µg/l)
220
200
180
160
140
120
100
80
60
40
20
0
JAN.
FEB.
MAR.
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.
1969

FIGURE V - 10

E. DISSOLVED OXYGEN IN THE MIDDLE AND LOWER ESTUARY

In the middle and lower Potomac Estuary, DO concentrations at lower depths are usually depressed under summer conditions. For the period of June 26 to 30, 1969, the DO in the bottom waters of the main channel for about 40 miles of the lower estuary was less than 2.0 mg/l. (Figure V-11) Similar observations were made by CTSL in July and August 1969 and by the Chesapeake Bay Institute (CBI) during a nutrient cruise in June of 1965 [4].

It appears that the low dissolved oxygen levels are associated with the salinity intrusion from Chesapeake Bay which has low DO at lower levels during the summer. While this may explain some of the dissolved oxygen depression, two major unanswered questions remain: (1) the effect of flows from the Potomac Estuary on water quality in the Chesapeake Bay, and (2) the contribution of the eutrophic condition in the upper and middle Potomac Estuary to the dissolved oxygen depression in the lower estuary and possibly in the Chesapeake Bay.

DO PROFILES
LOWER POTOMAC ESTUARY
JUNE 26-30, 1969

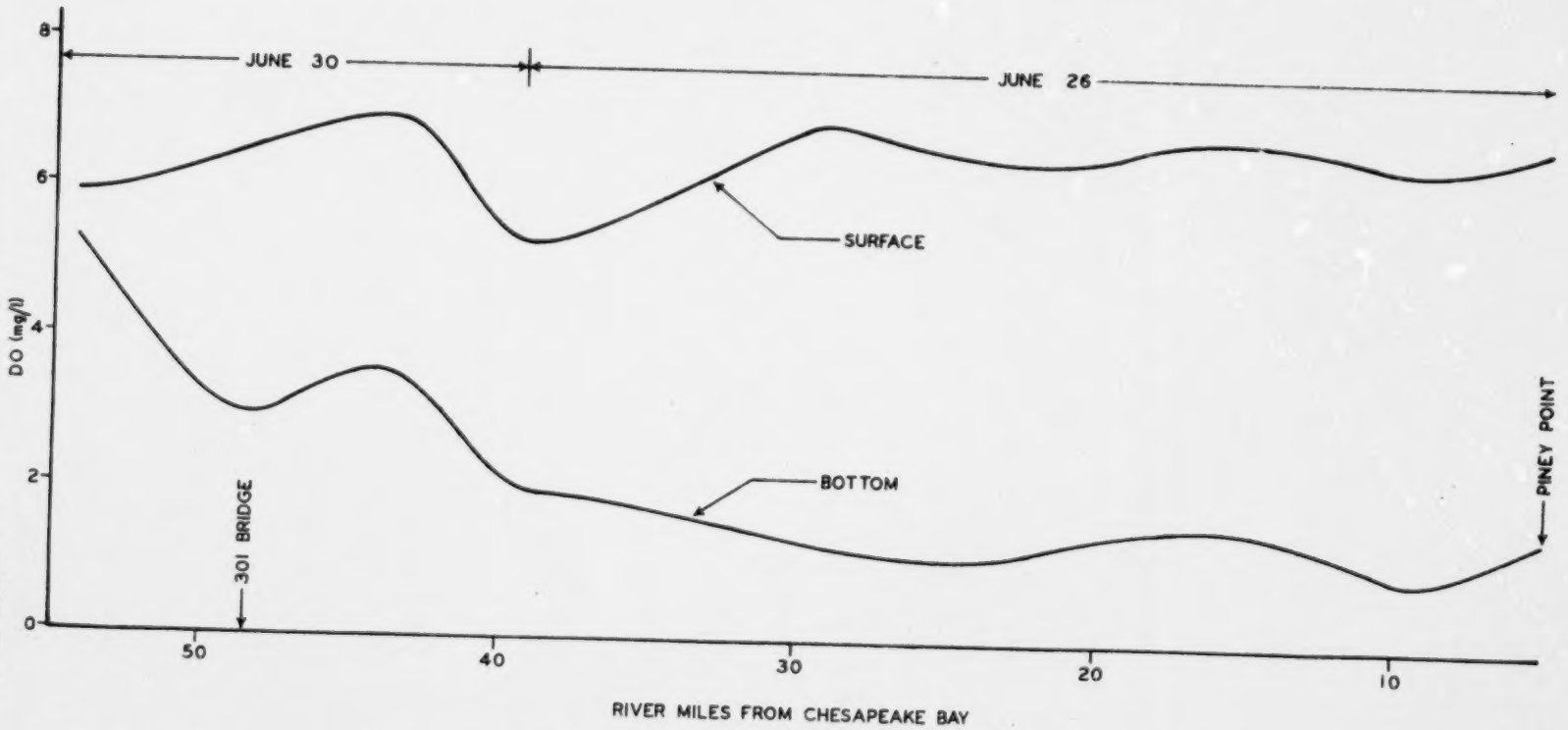

FIGURE V-11

F. CHLORINATED HYDROCARBON PESTICIDES

During August 5 to 11, 1969, samples obtained from six stations in the Potomac Estuary and a 24-hour composite sample of the final effluent from the D.C. facility at Blue Plains were analyzed for pesticides. The estuary stations sampled are as follows:

Station	Miles from Chesapeake Bay
Chain Bridge	106.5
Arlington Memorial Bridge	100.7
Woodrow Wilson Bridge	94.4
Piscataway	89.0
Indian Head	77.5
U.S. Route 301 Bridge	46.3

The compounds for which the samples were analyzed and the minimum detectable concentrations are presented in Table V-4.

No compounds were detected in any of the six estuary samples or in the 24-hour composite of the final effluent from the Blue Plains facility.

TABLE V-4

PESTICIDES ANALYZED AND

MINIMUM DETECTABLE LIMITS

Compound	Minimum Detectable Concentration ng/l
Dieldrin	5
Endrin	5
DDT	10
DDE	5
Heptachlor	5
Heptachlor Epoxide	5
Aldrin	5
BHC	5
Endosulphan	5
Chlordane (Tech.)	25
Toxaphene	1,000
Methoxychlor	25

* ng/l = nanograms/liter

CHAPTER VI

WASTEWATER CONTROL REQUIREMENTS

A. GENERAL

Nutrient removal or control is a relatively new concept in water quality management and consequently subject to various interpretations. During a technical workshop on Nutrient Removal Needs, Methods, and Costs at Fredericksburg, Virginia, May 13-14, 1969, a summary statement on nutrient removal concepts was developed as part of the panel* discussion and is presented below:

"1. Accelerated eutrophication is recognized as a significant form of pollution.

"2. In some waters this hypertrophy is so advanced that immediate action is needed.

"3. Phosphorus (P) and nitrogen (N) removal together will normally alleviate this environmental stress because:

(a) These elements are known to be nutrients to which the plant life is responsive at concentrations that are practical to manage; the actual levels will probably vary in different environments.

(b) The removal of either P or N alone will still allow the blooming of undesirable species leaving the ecosystem imbalanced; the more nearly natural condition of the wastewater, the less disturbance of the ecosystem.

"4. Processes to remove these nutrients that are mutually compatible have been developed which are adequate for preliminary engineering cost analysis."

* Panel members were: Dr. Donald W. Lear, Jr., Chief, Ecology Section, Chesapeake Technical Support Laboratory, FWPCA, Annapolis, Maryland; Dr. Kenneth Williams, Chief, Aquatic Ecology Activities, FWPCA, Athens, Georgia; Dr. Clair N. Sawyer, Senior Associate, Metcalf & Eddy, Inc., Boston, Massachusetts; Dr. Morris L. Brehmer, Virginia Institute of Marine Sciences, Gloucester Point, Virginia

This summary statement emphasizes two important concepts: (1) that eutrophication is a form of pollution, and (2) the nearer the quality of the waste discharge to natural conditions of the receiving waters the less it will disturb the ecosystem. Using the same basic concepts, maximum levels of BOD (organic carbon), nitrogen, and phosphorus were developed for the upper estuary.

To facilitate determination of water quality control requirements, the upper estuary was segmented into 15 mile zones beginning at Chain Bridge (Table VI-1 and Figure III-1). Establishment of zones similar in physical characteristics allows flexibility in developing control needs.

TABLE VI-1

ZONES OF UPPER POTOMAC ESTUARY

Zone and Description	River Mile of Upper End of Zone		River Mile of Lower End of Zone	
	from Chain Bridge	from Chesapeake Bay	from Chain Bridge	from Chesapeake Bay
I Chain Bridge to Broad Creek	0.0	106.5	15.0	91.5
II Broad Creek to Indian Head	15.0	91.5	30.0	76.5
III Indian Head to Maryland Point	30.0	45.5	76.0	61.5

B. ZONE I

In the FWPCA report, "Potomac River Water Quality, Washington, D. C. Metropolitan Area," a maximum total discharge of 16,500 lbs/day of BOD and 96 percent removal of phosphorus was recommended for waste treatment facilities in the enforcement area. The BOD loadings were determined with a simultaneous 85 percent reduction in nitrogenous oxygen demand.

The BOD and unoxidized nitrogen loadings were based upon maintaining an average DO of 5.0 mg/l for a fresh water inflow of 705 cfs which is the seven-day-low-flow with a recurrence interval of once-in-ten-years.

Total phosphorus loadings were determined, using a maximum phosphorus concentration in the upper estuary near the discharges at or below 0.1 mg/l as P. The phosphorus level in the reach from Piscataway to Possum Point would normally be below 0.04 mg/l as a result of maintaining the maximum level at 0.1 mg/l. This reach is currently most susceptible to algal growth.

Adopting the zonal concept, the conferees of the Potomac River-Washington Metropolitan Area Enforcement Conference agreed May 8, 1969, upon a BOD loading of 16,500 lbs/day and a phosphorus loading of 740 lbs/day (96 percent removal at current wastewater loadings). To further enhance the water quality in the upper estuary and to reduce any stimulation by discharges of large quantities of nitrate-nitrogen, the conferees recommended a total nitrogen loading be adopted equivalent to that required to meet the 85 percent reduction in nitrogenous oxygen demand or 8,000 lbs/day of total nitrogen.

C. ZONE II

Assuming that loadings for both carbonaceous and nitrogenous oxygen demands have been satisfied in Zone I, preliminary estimates of oxygen demand loading components for Zone II have been determined as shown in Figure VI-1. The loadings are based on a single discharge point into the main channel in the center of Zone II.

Since oxygen demanding loadings can be either carbonaceous or nitrogenous, an infinite combination of the two components exist which will achieve an average dissolved oxygen concentration of 5.0 mg/l for a water temperature of 29° C. at a fresh water inflow of 708 cfs. For example, Figure VI-1 shows that the 5.0 mg/l DO criterion can be met if the carbonaceous and nitrogenous oxygen demands are below 30,000 and 10,000 lbs/day, respectively.

Nutrient loadings for algal control have been determined as follows:

Parameter	Loadings in lbs/day
Total Phosphorus as P	1,100
Total Nitrogen as N	6,600

Since field studies are currently being conducted to further determine nutrient transport on an annual basis, the above nutrient loadings should be considered tentative.

In developing the above oxygen demanding and nutrient loading estimates, the following conditions were assumed:

a. Water Quality Criteria

(1) An average DO concentration of 5.0 mg/l

(2) A maximum phosphorus concentration of 0.1 mg/l as P

(3) A maximum inorganic nitrogen concentration of 0.5 mg/l as N

CARBONACEOUS AND NITROGENOUS OXYGEN DEMAND LOADINGS

FOR MAINTAINING AN

AVERAGE OF 5.0 mg/l OF DISSOLVED OXYGEN

IN

ZONE II

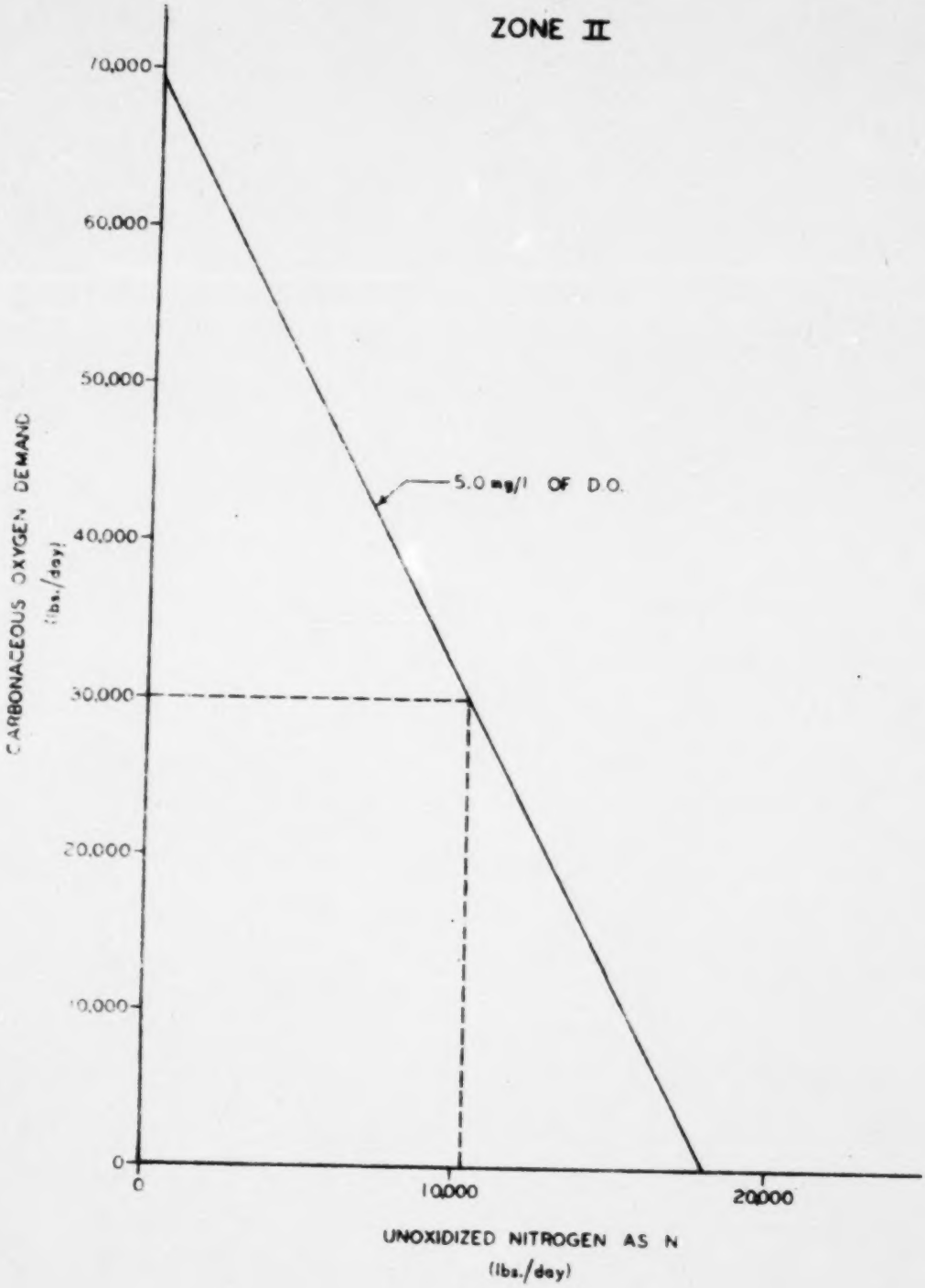

FIGURE VI-1

b. Environmental Conditions

(1) Water temperature of 29° C.

(2) Fresh water inflow of 705 cfs

c. Residual Concentrations from Zone I in the Center of Zone II

(1) An average DO of 6.9 mg/l

(2) A phosphorus concentration of 0.03 mg/l as P

(3) No residual carbonaceous or nitrogenous oxygen demanding material

(4) Inorganic nitrogen concentration of 0.1 mg/l

CHAPTER VII

CURRENT INVESTIGATIONS AND RESEARCH NEEDS

To aid in further determination of nutrient removal requirements, especially in the middle and lower portion of the estuary, field activities are continuing. An area of major emphasis for CTSL during the summer of 1969 was on the ecology of the middle estuary in the area of salinity intrusion. Studies are continuing to determine the effects of salinity on the rate limiting concentrations of nutrients in algal growth.

Another area of major emphasis is the transport of nutrients throughout the entire estuary. A cooperative study with the Steuart Petroleum Company, U.S. Army Corps of Engineers, Aqueduct Division, D.C. Department of Sanitary Engineering, and CTSL was initiated in February 1969. The major purposes were to determine the nutrient movement on an annual basis throughout the entire estuary, and to provide sufficient data upon which mathematical models can be verified. Data from this study will also be used to further define annual nutrient control requirements. Included will be a detailed analysis of nitrogenous oxygen demand removal requirement under winter conditions.

Cooperative laboratory and field studies are being made with the Southeast Water Laboratory of FWPCA to determine the role of carbon in algal growth stimulation. While preliminary data for the Potomac indicate that the control of carbon may not be feasible under

all conditions at the present time, the possible need for CO_2 control is also being considered especially in the design of advanced wastewater treatment.

Another important need is a eutrophication study involving rooted and emergent aquatic plants. The role of these plants in the Potomac estuarine ecology should be examined, including the effects of nutrient additions in relation to maximum utilization, retention, and recycling in an ecological system.

As indicated in Chapter V, depressed dissolved oxygen levels in the lower depths occur in the lower reaches of the estuary and in the Chesapeake Bay under summer conditions. These depressions are often considered "natural conditions." A need also exists for a further understanding of the effects of the highly eutrophic conditions in the upper and middle estuary on water quality in the lower estuary and in the Chesapeake Bay. For example, preliminary laboratory studies by CTSI indicate that remineralization of NH_3 nitrogen from algal cells can be a significant source of nitrogenous oxygen demand.

REFERENCES

1. Williams, Kenneth, "Nutrient-Phytoplankton Relationships," A Water Pollution Control Technical Workshop on Nutrient Removal Needs, Methods, and Costs. Fredericksburg, Virginia, May 13-14, 1969.

2. Kuentzel, L. W., "Bacteria, Carbon Dioxide and Algal Blooms," Presented at Industrial Waste Conference, Purdue University, May 6-8, 1969.

3. Jaworski, N. A., Lear, Donald W., Jr., and Aalto, Johan A., "A Technical Assessment of Water Quality Conditions and Factors Affecting Water Quality in the Upper Potomac Estuary," Technical Report No. 5, CTSL, MAR, FWPCA, U.S. Department of the Interior, May 1969.

4. Whaley, R. C., Carpenter, J. H., and Baker, R. L., "Nutrient Data Summary 1964, 1965, 1966," Special Report No. 17, Chesapeake Bay Institute, The Johns Hopkins University, Reference 66-9, November 1966.

TABLE A-1

UPPER POTOMAC ESTUARY INTENSIVE SURVEY
FIELD DATA
August 12-14, 1969

Station (and river mi. from Chain Bridge)		Water Temp. Top (°C)	Water Temp. Bottom (°C)	Secchi Disk (inches)	pH Top (unit)	pH Bottom (unit)	DO Top (mg/l)	DO Bottom (mg/l)	CO_2 mg/l Top (mg/l)	CO_2 mg/l Bottom (mg/l)
Indian Head	F*	26.0	24.5	16.0	6.7	7.0	5.8	5.8	7.2	9.5
(29.5)	E	27.5	26.8	10.3	7.4	7.1	7.0	5.5	9.4	9.4
Hallowing Pt.	F	26.5	26.1	10.0	7.2	7.3	6.1	5.5	8.0	9.0
(24.8)	E	27.5	26.7	12.6	7.0	6.8	5.8	3.9	12.5	18.6
Dogue Creek	F	26.6	25.6	13.3	7.0	7.0	5.0	4.3	10.0	8.4
(21.6)	E	27.1	26.8	11.3	6.9	6.7	4.7	2.5	17.6	15.2
Piscataway Ck.	F	26.3	25.8	11.0	6.7	6.8	3.5	2.8	11.6	12.8
(18.2)	E	27.0	26.4	10.6	6.9	6.7	3.1	2.3	15.1	16.8
Broad Creek	F	26.0	25.9	10.6	6.8	6.8	2.9	2.3	12.0	15.2
(14.6)	E	26.9	26.2	8.6	6.9	6.8	3.9	3.8	15.6	19.8
W. W. Bridge	F	26.1	26.1	8.0	6.7	6.8	4.0	3.1	10.8	14.2
(11.8)	E	26.9	25.8	9.0	7.1	6.9	6.3	5.4	9.8	14.4
Bellevue	F	25.7	25.2	5.6	6.8	6.9	5.0	4.4	10.9	12.9
(9.9)	E	27.4	26.0	7.0	7.1	7.0	6.4	5.5	14.1	17.0
Haines Point	F	25.6	25.1	5.0	7.0	6.8	5.7	5.1	7.8	9.9
(7.3)	E	26.5	26.1	7.3	7.4	7.2	7.3	7.1	11.5	11.4
14th St. Bridge	F	26.0	25.3	12.0	7.4	7.5	7.7	6.9	6.1	7.7
(5.7)	E	26.6	25.9	11.6	7.6	7.2	8.6	7.2	9.6	12.6
Key Bridge	F	26.3	26.3	12.6	7.2	7.4	7.4	7.2	7.1	8.4
(3.3)	E	26.5	26.3	12.0	7.6	7.3	8.1	7.7	9.4	10.6

* F - Flood Tide
E - Ebb Tide

TABLE A-2

UPPER POTOMAC ESTUARY INTENSIVE SURVEY
CHEMICAL ANALYSIS

August 12-14, 1969

Station (and river mi. from Chain Bridge)		TOC Top (mg/l)	TOC Mid-depth (mg/l)	TP as PO_4 (mg/l)	Pi as PO_4 (mg/l)	TKN (mg/l)	TKN mf Surface only (mg/l)	NO_2+NO_3 (mg/l)	NH_3 (mg/l)	Chloro-phyll (µg/l)	BOD Normal Mid-depth (mg/l)	BOD Inhibited Mid-depth (mg/l)
Indian Head	F*	10.40	7.09	.863	.499	2.072	.742	.77	.31	95.91	2.44	1.43
(29.5)	E	12.40	6.83	1.223	.421	4.246	-	.81	.37	269.25	4.08	2.22
Hallowing Pt.	F	14.50	6.92	1.104	.427	3.682	.738	.84	.45	201.00	3.55	.89
(24.8)	E	8.06	7.02	.591	.500	2.248	-	.95	.61	90.75	3.87	1.91
Dogue Creek	F	7.41	7.13	.810	.562	1.617	1.080	.97	.71	47.50	2.87	.30
(21.6)	E	7.74	6.96	.896	.617	2.029	-	1.02	.77	37.00	2.69	1.31
Piscataway Ck.	F	7.29	7.39	.909	.635	1.717	1.148	1.02	.85	28.00	3.88	2.66
(18.2)	E	7.81	8.10	.992	.751	2.430	-	.86	.89	27.50	3.64	2.23
Broad Creek	F	7.73	7.10	1.006	.729	1.686	.914	.90	.76	17.00	3.34	3.30
(14.6)	E	8.45	7.65	1.184	.761	1.137	-	.85	.68	24.25	4.66	2.10
W. W. Bridge	F	8.66	7.75	1.159	.751	1.423	1.745	.83	.80	14.75	4.34	2.28
(11.8)	E	9.43	7.52	.609	.691	1.837	-	.90	.83	33.50	4.03	3.11
Bellevue	F	9.10	8.29	1.664	1.029	2.170	1.397	1.28	1.14	42.75	7.62	5.30
(9.9)	E	7.75	7.40	1.484	.919	1.884	-	1.20	.82	42.50	6.61	1.82
Haines Point	F	7.43	7.20	.647	.276	1.007	.569	.88	.29	26.25	3.84	2.99
(7.3)	E	7.56	7.06	.441	.153	.922	-	.91	.07	27.00	3.97	1.46
14th St. Bridge	F	6.38	5.90	.323	.133	.702	.374	.96	.13	30.75	3.23	.63
(5.7)	E	7.30	5.88	.323	.118	.786	-	.93	.04	52.50	2.10	2.37
Key Bridge	F	6.24	5.95	.305	.134	.674	.389	1.01	.11	27.25	2.34	1.21
(3.3)	E	6.11	5.78	.318	.140	1.020	-	.92	.05	39.75	2.15	1.80

* F - Flood Tide
E - Ebb Tide

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TABLE A-3
POTOMAC RIVER BACTERIOLOGICAL SURVEY
July 31 - August 5, 1969
CHESAPEAKE TECHNICAL SUPPORT LABORATORY

Date Sample Taken	Time Sample Taken	Water Temp °C	Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococcus MPN/100 ml	FC/FS Ratio	Salmonella* Isolates
		Great Falls (Water Intake)					
7-31	0935	27	11,000	1,700	440	3.8	-
8-1	1200	28.5	3,300	2,300	310	7.4	
8-2	0950	27	13,000	LA	2,900		
8-3	1000	26	35,000	7,900	12,000	.6	
8-4	1000	26	24,000	1,000	1,400	.7	
8-5	0900	25.5	4,900	1,300	890	1.4	
		Little Falls (Water Intake)					
7-31	1025	27	3,300	230	420	.5	+
8-1	1105	28	2,200	170	220	.7	
8-2	1030	28	11,000	LA	5,000		
8-3	1100	26.5	17,000	790	2,600	.3	
8-4	1055	25	24,000	2,300	3,500	.6	
8-5	1055	23	13,000	330	930	.3	
		Chain Bridge					
7-31	1050	26	1,100	170	540	.3	(Lost)
8-1	1030	28	790	230	470	.4	
8-2	1100	26	7,900	LA	1,900		
8-3	1130	26	92,000	1,400	49,000	.1	
8-4	1115	25	24,000	2,300	1,500	1.5	
8-5	1110	25	7,900	700	740	.9	
		Key Bridge					
7-31	1120	28	3,300	490	260	1.8	-
8-1	0945	28	3,300	40	230	.2	
8-2	1125	27	4,900	LA	1,600		
8-3	1205	27.5	11,000	790	1,700	.4	
8-4	1140	25	11,000	1,100	1,200	.9	
8-5	1135	26	4,600	1,300	520	2.5	
		Memorial Bridge					
7-31	1155	27	7,000	1,000	220	4.5	+
8-1	1000	28	7,900	490	130	3.7	
8-2	1150	27	92,000	LA	910		
8-3	1230	26	28,000	7,000	5,800	1.2	
8-4	1400	26	160,000	24,000	6,800	3.5	
8-5	0950	26	13,000	1,300	710	1.8	
		Woodrow Wilson Bridge					
7-31	1225	27	49,000	4,900	170	28.8	+
8-1	1045	29	1,000	790	16	49.3	
8-2	1215	27	33,000	LA	280		
8-3	1255	27	49,000	13,000	2,000	6.5	
8-4	1300	26.5	240,000	23,000	940	24.4	
8-5	1025	25.5		1,700	400	4.2	

* - is negative, + = positive

TABLE A-4

BACTERIOLOGICAL SURVEY
POTOMAC ESTUARY
March 24 - April 4, 1969
CHESAPEAKE TECHNICAL SUPPORT LABORATORY

Date Sample Taken	Time Sample Taken	Water Temp °C	Secchi Disk Inches	pH	DO mg/l	Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Streptococci MPN/100ml	Preliminary Salmonella MF Water Sample Volume	Recovery	Swab Recovery
						Cabin John Bridge					
3-24	1115	10.2				490	20	< 20	450ml	-	
3-25	0930	11				1,720	210	< 20	450ml	-	
3-26	0945	10		7.55	11.65	5,420	490	20	200ml	-	
3-27	0920	7				9,180	940	40	200ml	-	-
3-28	0915	6.5				16,090	490	130	200ml	+ ?	
3-29	1410	9				5,420	1,300	20	200ml	-	
3-30	0935	7				3,480	400	< 20			
						Key Bridge					
3-24	1450	10.5				13,000	500	200	450ml	-	+ ?
3-25	1210	11		6.6		2,600	400	< 200			
3-26	1040	11	28		10.97	500	< 200	400			
3-28	1615					13,000	2,300	500			
3-29	1030	8.5	6			17,200	1,700	500			
3-30	1015	8.5	12			1,700	800	200			
						Rock Creek - M Street Bridge					
3-25	1005	10.5				348,000	240,000	4,000	150ml	+ ?	
3-26	1015	9		6.7	10.15	17,000	2,000	5,000			
3-27	0920	6.5				4,000	< 2,000	< 2,000	150ml	-	
3-28	0940	5				< 2,000	< 2,000	< 2,000	150ml	-	
3-29	1335	11				LA	LA	LA			
3-30	1000	7.5				< 2,000	< 2,000	< 2,000			

LA Laboratory accident

Date Sample Taken	Time Sample Taken	Water Temp °C	Secchi Disk Inches	pH	DO mg/l	Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Streptococci MPN/100ml	Preliminary Salmonella MF Water Sample Volume	Recovery	Swab Recovery
						Tidal Basin					
3-24	1200	6				500	< 200	< 200			
3-25	1030	10				< 200	< 200	< 200			
3-26	1030	10		7.8	11.02	5,420	1,720	220			
3-27	1000	9.5				490	330	40			
3-28	0955	9				1,700	500	< 200	150ml	-	
3-29	1320	10				3,480	1,090	50			
3-30	1015	7				1,090	270	20			
						14th Street Bridge					
3-24	1345	11				800	< 200	< 200			+ ?
3-25	1150	11		6.7		4,600	1,300	200	150ml	-	
3-26	1050	10.5	30		10.41	800	200	< 200	200ml	+	
3-28	1635	8.5				13,000	1,300	< 200			
3-29	1040	8.5	6			4,900	700	< 200	150ml	-	
3-30	1035	8.5	12			10,900	1,700	< 200			
						Haines Point, Buoy 2					
3-24	1330	10.5				200	< 200	200	450ml	+	
3-25	1145	11		6.4		160,900	4,900	200	150ml	-	
3-26	1100	10.5	25		10.27	1,300	< 200	200	200ml	-	
3-28	1650	8.5				54,200	2,200	< 200			
3-29	1050	9	6			2,600	1,300	< 200	150ml	-	
3-30	1050	8.5	12			4,900	800	< 200			
						Anacostia River - Sousa Bridge					
3-24	1315	11				2,000	< 2,000	< 2,000			-
3-25	1120	12		6.4		109,000	11,000	2,000	150ml	+	
3-26	1115	11.5	8		7.66	23,000	23,000	4,000	200ml	+	
3-28	1655	11.5				23,000	5,000	< 2,000			
3-29	1103	11.5	6			< 2,000	< 2,000	< 2,000	150ml	-	
3-30	1110	11	6			23,000	5,000	< 2,000			

Date Sample Taken	Time Sample Taken	Water Temp °C	Secchi Disk Inches	pH	DO mg/l	Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Streptococci MPN/100ml	Preliminary Salmonella MF Water Sample Volume	Recovery	Swab Recovery
						Bolling Air Force Base, Buoy 9					
3-24	1245	10.5				160,900	LA	1,700	450ml	-	-
3-25	1045	10.5		6.8		34,800	7,900	2,300	150ml	-	
3-26	1120	10.5	27		10.39	7,900	< 200	< 200	200ml	-	
3-28						24,000	1,300	< 200	150ml	-	
3-29	1130	9	8			10,900	900	< 200			
3-30	1130	8.5	11			1,700	500	< 200			
						Woodrow Wilson Bridge					
3-24	1230	10.5				160,900	24,000	1,300	450ml	+	-
3-25	1030	11		6.7		> 160,900	54,000	3,300	150ml	+	
3-26	1130	10.5	24		9.10	918,000	33,000	< 2,000	200ml	+	
3-28						24,000	1,100	200	150ml	-	
3-29	1140	9	8			2,000	< 2,000	< 2,000			
3-30	1205	8.5	11			8,000	2,000	< 2,000			
						Broad Creek, Buoy 86					
3-24	1150	10.2				3,300	800	< 200	450ml	+	-
3-25	1015	11		6.6		34,800	4,900	800	150ml	+	
3-26	1140	31			8.85	160,900	13,000	3,300	200ml	-	
3-28						22,100	1,300	< 200	150ml	-	
3-29	1158	8.5	12			4,900	500	< 200			
3-30	1215	9	11			54,200	700	< 200			
						Piscataway Creek, Buoy 75					
3-24	1630	10.3				3,300	500	< 200	450ml	+	-
3-25	0945	12.5		6.6		4,600	400	< 200	150ml	-	
3-26	1215	10.5	27		8.85	54,200	2,300	400	200ml	-	
3-28						10,900	2,600	< 200	150ml		
3-29	1218	9	12			10,900	1,700	< 200			
3-30	1225	9	12			7,900	4,900	< 200			

LA Laboratory accident

Date Sample Taken	Time Sample Taken	Water Temp °C	Secchi Disk Inches	pH	DO mg/l	Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Streptococci MPN/100ml	Preliminary Salmonella MF Water Sample Volume	Recovery	Swab Recovery
						Dogue Creek, Buoy 67					
3-24	1200	8.5	22	7.55		400	< 200	< 200			-
3-25	1200	9.5	20			800	< 200	< 200			
3-26	1225	10	23		10.11	9,180	230	< 20	200ml	-	
3-28	1055	9.5	18			17,200	900	< 200	150ml	+ ?	
3-29	1330					16,090	2,210	< 20	150ml		
3-30	0950	8.5				9,180	790	20			
						Hallowing Point, Buoy 61					
3-24	1218	9	18	8.2		< 200	< 200	< 200			- ?
3-25	1235	10	15			800	< 200	< 200			
3-26	1235	9	12		11.90	140	< 20	20	200ml	-	
3-28	1041	9.5	24			34,800	3,300	< 200	200ml	-	
3-29	1300					1,090	230	< 20	200ml		
3-30	1020	9				9,180	1,300	50			
						Indian Head, Buoy 54					
3-24	1230	9	20	7.8		< 200	< 200	< 200			+ ?
3-25	1220	9	18			< 200	< 200	< 200			
3-26	1250	9	18		12.96	170	20	20	200ml	-	
3-28	1024	9.5	24			34,800	7,000	< 200	200ml	-	
3-29	1245					3,480	1,300	< 20	150ml	-	
3-30	1105	9				1,720	330	40			
						Possum Point, Buoy 44					
3-24	1257	8	24	8.25		< 200	< 200	< 200			-
3-25	1207	9	22			< 200	< 200	< 200			
3-26	1355	8	22		12.74	130	20	< 20			
3-28	1005	8.5	18			700	200	< 200			
3-29	1205					110	< 20	20			
3-30	1130	8.5				1,300	140	20			

Date Sample Taken	Time Sample Taken	Water Temp °C	Secchi Disk Inches	pH	DO mg/l	Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Streptococci MPN/100ml	Preliminary Salmonella MF Water Sample Volume	Preliminary Salmonella MF Water Sample Recovery	Preliminary Salmonella Swab Recovery
						Smith Point, Buoy 30					
3-24	1328	8	62	7.6		< 20	< 20	< 20			-
3-25	1143	9	52			< 20	< 20	< 20			
3-26	1430	8			11.54	50	< 20	< 20			
3-28	0943	8	24			40	< 20	< 20			
3-29	1120					20	< 20	< 20			
3-30	1145					50	< 20	< 20			
						Maryland Point, Buoy 19					
3-24	1350	8	49	7.3		< 20	< 20	< 20			
3-25	1125	8	64			< 20	< 20	< 20			-
3-26	1458	8	45		12.14	< 20	< 20	< 20			
3-28	0925	7.5	36			20	< 20	< 20	200ml	-	
3-29	1050	9				20	< 20	< 20	200ml	-	
3-30	1220	8				50	< 20	< 20	150ml	-	
						Nanjemoy Creek, Buoy 11					
3-24		8		7.2		20	< 20	< 20			
3-25	1105	7.5	58			< 20	< 20	< 20			-
3-26	1520	8	60		11.83	< 20	< 20	< 20			
3-28	0905	7.5	48			50	< 20	< 20			
3-29	1015	8				< 20	< 20	< 20			
3-30	1300	9				< 20	< 20	< 20			
						301 Potomac River Bridge					
3-24	1510	9	58	7.8		< 20	< 20	< 20			-
3-25	1040	7.5	46			20	< 20	< 20			
3-26	1600	7.5	52		11.83	< 20	< 20	< 20			
3-28	0838	7.5	72			20	< 20	< 20			
3-29	0930	8				< 20	< 20	< 20			
3-30	1345	8				< 20	< 20	< 20			

Date Sample Taken	Time Sample Taken	Water Temp °C	Secchi Disk Inches	pH	DO mg/l	Coliform MPN/100ml	Fecal Coliform MPN/100ml	Fecal Streptococci MPN/100ml	Preliminary Salmonella MF Water Sample Volume	Preliminary Salmonella MF Water Sample Recovery	Preliminary Salmonella Swab Recovery
						Lower Cedar Point, Buoy 33					
3-24		9	30	8.1		40	< 20	< 20			
3-25	1030	7.5	42			20	< 20	< 20			
3-26	1545	7.5	54		11.41	20	< 20	< 20			
3-28	0830	8	72			< 20	< 20	< 20			
3-29	0922	7.5				< 20	< 20	< 20			
3-20	1355	8				< 20	< 20	< 20			
						Piney Point					
3-24	1400	4				20	< 20	< 20			
3-25	1310	12				20	< 20	< 20	150ml	-	
3-26	1235	7		7.4	10.76	< 20	< 20	< 20	200ml	-	
3-27	1200	6.5				< 20	< 20	< 20			
3-28	1155	8				< 20	< 20	< 20			
3-29	1030	7				< 20	< 20	< 20			
3-30	1230	8				< 20	< 20	< 20			

TABLE A-5

POTOMAC ESTUARY DATA
WATER POLLUTION CONTROL DIVISION
Department of Sanitary Engineering
District of Columbia

September 29, 1969

Station	Sampling Time	Water Temp. (°C)	D.O. (mg/l)	BOD (mg/l)	Coliform (MPN per 100 ml)	Fecal Coliform (MPN per 100 ml)	Chloride mg/l
	AM						
Ch. Bridge	8:03	20.0	8.6	4	24,000	360	15
Fl. B.H.	8:28	20.0	8.8	5	9,300	23	15
Th. Sis.	8:48	20.5	7.3	4	4,300	36	15
Roose. I.	9:05	20.9	8.6	5	7,300	73	15
Mem. Br.	9:20	20.6	9.9	4	9,300	23	16
Hwy. Br.	9:35	20.0	8.5	4	4,300	73	18
Pot. Pk.	9:40	20.0	8.4	4	2,400	23	17
Hains Pt.	9:50	20.4	6.3	4	4,300	91	18
Gies. Pt.	10:03	20.9	5.6	4	9,300	230	25
Ab. WPCP	10:15	21.0	4.6	9	240,000	360	21
Op. WPCP	10:25	21.5	6.4	4	9,300	230	25
Be. WPCP	10:33	21.0	5.0	4	43,000	1,500	30
WW. Bridge	10:48	21.3	3.3	5	21,000	230	29
Ft. Ft.	11:20	21.6	3.7	7	7,300	230	26
Ft. Wash.	11:55	21.5	3.8	7	2,400	23	24
M. Hall	12:38	21.7	6.8	3	430	23	20
Hall. Pt.	1:13	21.5	6.0	5	930	36	13
Ind. Hd.	1:43	21.5	6.2	5	930	9	11
St. Neck	2:18	21.4	9.5	5	9,300	2	38
San. Pt.	3:02	21.4	8.3	3	2,400	2	100
Sm. Pt.	3:38	21.4	12.0	5	2,400	2	120
Md. Pt.	4:13	21.1	8.8	3	430	2	347